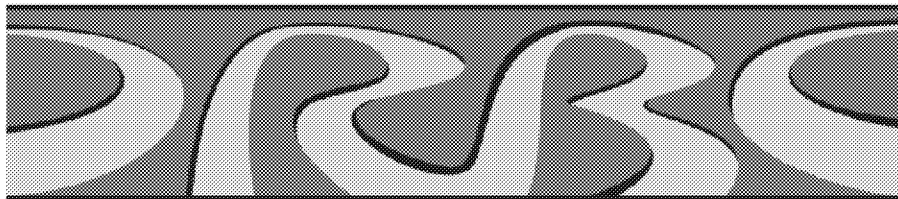


2016 Delaware River and Bay Water Quality Assessment

DELAWARE RIVER BASIN COMMISSION



Delaware River Basin Commission

DELAWARE • NEW JERSEY
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UNITED STATES OF AMERICA

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August 2016

Acknowledgements

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Suggested Citation

DRBC. 2016 Delaware River and Bay Water Quality Assessment. Delaware River Basin Commission. West Trenton, NJ. August 2014.

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Introduction and Overview

The 2016 Delaware River and Bay Water Quality Assessment (2016 Assessment) reports the extent to which waters of the Delaware River and Bay are attaining designated uses in accordance with Delaware River Basin Commission's Water Quality Regulations (18 CFR 410, DRBC WQR) for the period October 1, 2010 through September 30, 2015. The designated water uses to be protected within the Delaware Basin are as follows:

- 1) Agricultural, industrial, and public water supplies after reasonable treatment, except where natural salinity precludes such uses;
- 2) Wildlife, fish and other aquatic life;
- 3) Recreation;
- 4) Navigation;
- 5) Controlled and regulated waste assimilation to the extent that such use is compatible with other uses; and
- 6) Such other uses as may be provided by the Commission's Comprehensive Plan (2001).

The assessment involves comparison of several key water quality parameters with applicable DRBC water quality criteria. DRBC regulations designate public water supply, agricultural, and industrial uses for the Delaware River. Since the public water supply use is assessed and protective of the other uses, agricultural and industrial uses are not assessed separately for this report. For each designated use in each assessment unit, a number of water quality parameters, relevant to the use, are compared to the existing, applicable water quality criteria.

Background

This assessment follows previous similar efforts performed beginning in 1996 and published under the DRBC Water Quality Assessment Reports/305(b) banner of the DRBC web site at: <http://www.state.nj.us/drbc/about/public/publications/index.html>

DRBC's water quality assessment report has been developed every even numbered year since its initiation. While DRBC does perform a water quality assessment function consistent with Section 305(b) of the Clean Water Act, only the states list water bodies not meeting standards, as per section 303(d). The DRBC does not list, but provides its assessment to the states for consideration in their listing determinations.

Pennsylvania, New Jersey, Delaware, and New York consider this assessment, in the context of their own EPA approved assessment and listing methodologies, to determine whether sections of the mainstem Delaware River should be listed on the state 303(d) list by a certain pollutant(s). Because their methodologies differ, listing decisions for shared waters are not automatically consistent.

Delaware River Basin

The Delaware River is the longest un-dammed river east of the Mississippi, extending from the confluence of its East and West branches at Hancock, N.Y. to the mouth of the Delaware Bay. The Delaware River is fed by 216 tributaries, the largest being the Schuylkill and Lehigh Rivers in Pennsylvania. In all, the basin contains approximately 13,500 square miles, draining parts of Pennsylvania (50.3 percent of the basin's total land area); New Jersey (23.3%); New York (18.5%); and Delaware (7.9%) (Figure 1).

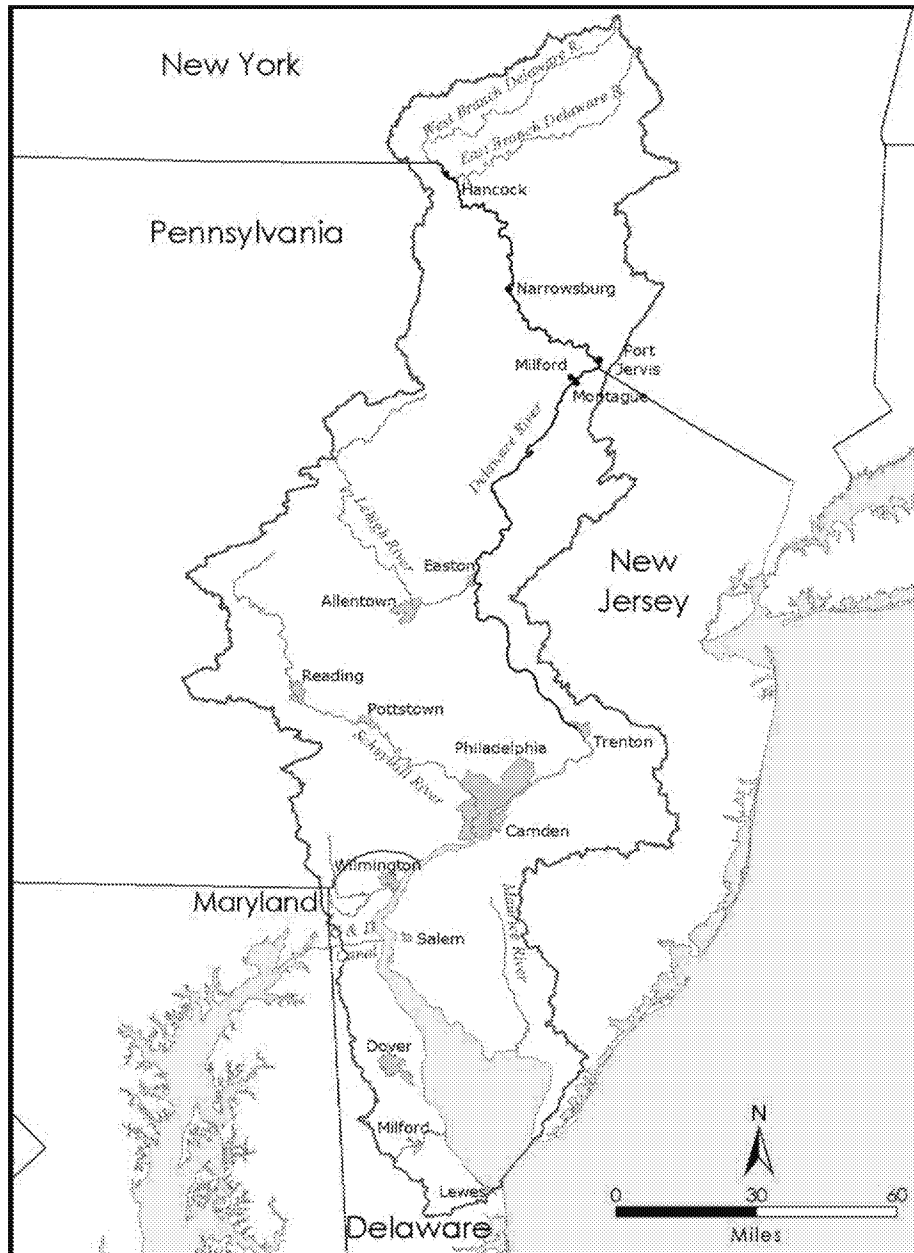
Approximately 15 million people, or about 5% of the U.S. population, rely on the waters of the Delaware River Basin for drinking and industrial use, and the Delaware Bay is only a one to two hour drive away for about 20% of the people living in the United States. Yet the basin drains only four-tenths of one percent of the total continental U.S. land area. The population of the Delaware River Basin in 2010 stood at approximately 8.26 million people. Table 1 provides additional geographical statistics for the Delaware River Basin. The Delaware Bay and tidal reach of the Delaware River have been included in the National Estuary Program, a partnership initiative authorized by Section 320 of the Clean Water Act designed to protect estuarine systems of national significance.

Three reaches of the Delaware River have been included in the National Wild and Scenic Rivers System. One section extends 73 miles from the confluence of the river's East and West branches at Hancock, NY, downstream to Milrift, PA; the second is a 40-mile stretch from just south of Port Jervis, NY, downstream to the Delaware Water Gap near Stroudsburg, PA. The Lower Delaware Wild and Scenic Rivers Act, signed into law on November 1, 2000, adds approximately 65 miles of the Delaware and selected tributaries to the national system, linking the Delaware Water Gap and Washington Crossing, PA, just upstream of Trenton, N.J. Almost the entire non-tidal Delaware River (the portion north of the "fall line" at Trenton, NJ) is included in the National Wild and Scenic Rivers System. In addition, 35.4 miles of the Maurice River and its tributaries in New Jersey and approximately 190 miles of the White Clay Creek and its tributaries in Pennsylvania and Delaware have been included in the national system. Most recently, on December 22, 2006, President George W. Bush signed into law the Musconetcong Wild and Scenic Rivers Act, which designates 24.2 miles of the Musconetcong River (a tributary of the Delaware River located in New Jersey) as a component of the National Wild and Scenic Rivers System.

There are numerous economic benefits from the river. The Delaware River Port Complex (including docking facilities in Pennsylvania, New Jersey, and Delaware) is the largest freshwater port in the world. According to testimony submitted to a U.S. House of Representatives subcommittee in 2005, the port complex generates \$19 billion in annual economic activity. It is one of only 14 strategic ports in the nation transporting military supplies and equipment by vessel to support our troops overseas. The Delaware River and Bay is home to the third largest petrochemical port as well as five of the largest east coast refineries. Nearly 42 million gallons of crude oil are moved on the Delaware River on a daily basis. There are approximately 3,000 deep draft vessel arrivals each year and it is the largest receiving port in the United States for Very Large Crude Carriers (tank ships greater than 125,000 deadweight tons). It is the largest North American port for steel, paper, and meat imports as well as the largest importer of cocoa beans and fruit on the east coast. Over 65% of Chilean and other South American fruits imported into the United States arrive at terminal facilities in the tri-state port complex. Wilmington, Delaware

is home to the largest U.S. banana importing port, handling over one million tons of this cargo annually from Central America. According to Rear Admiral Sally Brice-O'Hara, District Commander of the Fifth Coast Guard District, "The port is critical not only to the region, but also to the nation."

Figure 1: Delaware River Basin



In addition, Dr. Gerald Kauffman of the University of Delaware has estimated that the Delaware River Basin provides \$25 billion annually in economic activity, including recreation, water quality, water supply, and hunting and fishing, \$21 billion annually in ecosystem goods and services (natural capital), and \$10 billion in annual wages.

Table 1: Approximate Geographical Statistics for the Delaware River Basin

Total Basin Land Area (mi ²) ^{a,b}	12,700
Population (2010)	8.26 million
Major River Basins (HUC 8) ^c	13
River Miles (Named) ^a	9,080
Border (Shared) River Miles ^a	339
Square Miles of Public Lakes and Reservoirs ^c	140
Square Miles of Estuary/Bay ^c	783
Square Miles of Wetlands ^c	480

^aDRBC GIS files

^bTotal Basin area minus area of Estuary and Bay

^cNational Hydrographic Dataset

Delaware River Water Quality Assessment

Water Quality Standards

Water quality standards provide a description of water body uses to be protected, as well as water quality criteria necessary to protect those uses. DRBC's water quality standards program derives its authority from Section 3.2 of the Delaware River Basin Compact (1961) which directs the Commission to adopt "a comprehensive plan...for the immediate and long range development and uses of the water resources of the basin" and to adopt "a water resources program, based upon the comprehensive plan, which shall include a systematic presentation of the quantity and quality of water resources needs of the area..."; and Section 5.2 which allows the Commission to "assume jurisdiction to control future pollution and abate existing pollution in the waters of the basin, whenever it determines...that the effectuation of the comprehensive plan so requires."

Designated Uses

Water uses are paramount in determining stream quality criteria, which, in turn, are the basis for determining discharge effluent quality requirements. Water quality standards require that all surface waters of the Basin be maintained in a safe and satisfactory condition for the following six (6) uses:

- Agricultural, industrial and public water supplies after reasonable treatment, except where natural salinity precludes such uses;
- Wildlife, fish and other aquatic life;
- Recreation;
- Navigation;
- Controlled and regulated waste assimilation to the extent that such use is compatible with other uses; and
- Such other uses as may be provided by the Commission's Comprehensive Plan.

The Delaware River and Bay consists of a non-tidal and tidal Zone. Zones C1-8 and intrastate streams (Zones E, W1, W2, N1 and N2) are not assessed in this report as they are assessed in the Integrated Reports of the Basin States. The non-tidal main stem consists of five Water Quality Management (WQM) Zones: 1A, 1B, 1C, 1D, and 1E (Figure 2). These Zones form the boundaries for the DRBC's assessment units (AUs) in the non-tidal Zone. The Zones as defined by river mile (RM) are included in Table 2. The designated uses applicable to the non-tidal AUs include aquatic life, fish consumption, primary contact recreation, and drinking water (Table 3).

The tidal Delaware River consists of AU 2, 3, 4, and 5 (Figure 2) and extends from RM 133.4 to RM 48.2 (Table 2). Assessment unit 6 (Delaware Bay) includes multiple units that are defined in part by shellfish management areas issued by the states of Delaware and New Jersey. The uses designated in the estuary and bay are indicated in Table 3. Shellfish consumption only applies to WQM Zone 6.

Figure 2: Delaware River Water Quality Management Zones / Assessment Units

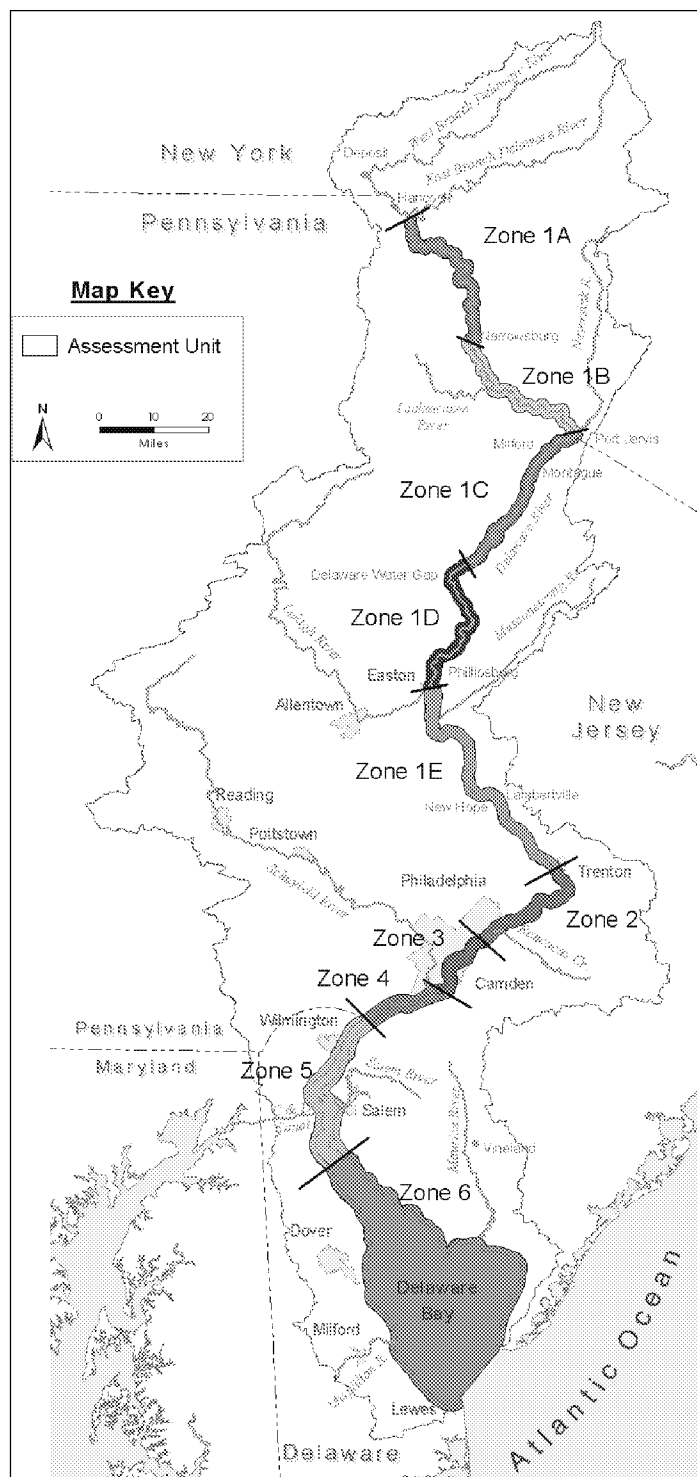


Table 2: Delaware River Water Quality Management (WQM) Zones

WQM Zone	Location (as River Mile)
1A	330.7 – 289.9
1B	289.9 – 254.75
1C	254.75 – 217.0
1D	217.0 – 183.66
1E	183.66 – 133.4
2	133.4 – 108.4
3	108.4 – 95.0
4	95.0 – 78.8
5	78.8 – 48.2
6	48.2 – 0.0

Table 3: Designated Uses by DRBC Water Quality Management Zones

Designated Water Use	Water Quality Management Zone									
	1A	1B	1C	1D	1E	2	3	4	5	6
Aquatic Life	X	X	X	X	X	X	X	X	X	X
Public Water Supply	X	X	X	X	X	X	X			
Recreation										
Primary & Secondary	X	X	X	X	X	X		X ^A	X	X
Secondary only							X ^A	X ^A		
Fish Consumption	X	X	X	X	X	X	X	X	X	X
Shellfish Consumption										X

^A Primary recreation below RM 81.8; Secondary recreation above RM 81.8

Criteria

Sections 3.10, 3.20, and 3.30 of DRBC's Water Quality Regulations define the "Stream Quality Objectives." From this point on, the objectives will be referred to as "Water Quality Criteria" (WQC) for the tidal and non-tidal river. Criteria are Zone-based and define the water quality

necessary to protect the designated uses in those Zones. For the water quality assessments, monitored data are compared against the Zone standards for determining use attainment.

Zones 1, 2 and 3 of the Delaware River are given the designated use of “public water supplies after reasonable treatment.” It is the general policy of DRBC that all ground water of the Basin, as well as surface sources of drinking water, should be maintained to support drinking water (18 CFR Part 410, 3.10.3.B, 3.40.4). In Zones 2 and 3, there is additional definition of the permissible levels of specific toxicants in waters designated for both drinking water and fish consumption (due to the bioaccumulation of certain substances even at very low ambient levels).

Assessment Methods

Because DRBC’s role is to assess shared waters in the Basin, coordination with the Basin States is important. The Integrated Listing process includes a list of waters for which TMDLs must be prepared (i.e., 303(d) list). However, the regulatory responsibility for preparing a 303(d) list rests with the States. DRBC published the Draft Methodology for the 2016 Delaware River and Bay Water Quality Assessment on its web site in September 2015, with subsequent notification to advisory committee members including representatives from state and federal environmental protection agencies and participants. A notice with a link to the methodology was published in the Federal Register on October 22, 2015. Minor corrections and clarifications to the Methodology were made in response to comments submitted by Pennsylvania. Those edits and clarifications are reflected in the Methodology summary provided here.

Assessment Units

As noted in the previous section, the non-tidal assessment units include WQM Zones 1A, 1B, 1C, 1D, and 1E. The designated uses assessed in Zones 1A through 1E include aquatic life, public water supply, primary recreation, and fish consumption. WQM Zones 2, 3, 4, and 5 make up the tidal portion of the Delaware River Basin. Fish consumption, aquatic life, and recreation apply to all the tidal Zones. In the estuary, the public water supply use is only applicable to WQM Zones 2 and 3. The Delaware Bay consists of WQM Zone 6. The assessed designated uses for the Bay include aquatic life, primary recreation, fish consumption, and shellfish consumption.

Data Window

This assessment considers all readily available data collected in the 5-year period from October 1, 2010 through September 30, 2015.

Data Sets

This assessment considers all readily available data. To obtain the data, DRBC queried the EPA STORET database, the USGS NWIS database, the NOAA PORTS database, as well as internal DRBC databases. We also published a data solicitation in the Federal Register. The majority of the data considered is from the following monitoring programs and/or data sets:

- USGS continuous real time monitors via NWIS;
- USGS surface water monitoring programs via NWIS;

- DRBC / NPS Scenic Rivers Monitoring Program (SRMP) covering the Upper, Middle, and Lower non-tidal Delaware River and tributaries;
- DRBC Biological Monitoring Program;
- DRBC Boat Run monitoring program;
- DRBC Chronic Toxicity Monitoring;
- NOAA PORTS continuous data;
- PAWQN Monitoring program via STORET;
- NY Department of Environmental Conservation, Division of Water, via STORET;
- NJDEP Bureau of Freshwater and Biological Monitoring via STORET;
- Delaware Department Of Natural Resources And Environmental Control via STORET;
- NJDEP Bureau of Marine Water Monitoring via STORET;
- Philadelphia Water Department Monitoring programs.

Other data sets contained in STORET were considered as well, but represented a small subset of the overall available data.

Analytical Parameters supporting Designated Uses

Data Requirements

This section looks at the general approach for each designated use assessed relative to DRBC water quality criteria and other supporting evidence. The tables below also describe the parameter-specific data requirements. It should be noted, however, that assessments might also be made using less robust data than indicated by the data requirements, when the weight of evidence is compelling.

Listed below are cases where insufficient data (ID) are available and the uses cannot be assessed against DRBC criteria. Such data would fail to support the designated use, but the assessment may be identified as “ID” rather than “not supported” when the following conditions exist:

- a) The number of samples per AU over an assessment period or season was below data requirements as defined in Tables 4 through 9
- b) Background level was not specified in DRBC WQR and cannot reasonably be determined for a particular AU
- c) The parameter was not monitored in an AU
- d) The parameter was analyzed in a matrix other than surface water

Aquatic Life

Aquatic life is to be protected in all DRBC WQM Zones. The assessment is based upon these water quality parameters: dissolved oxygen (DO), pH, turbidity, temperature, total dissolved solids (TDS), alkalinity, and in Zone 1, biological monitoring results. In addition, toxic pollutants with acute and chronic criteria are used to support aquatic life in Zones 2 through 6, which

correspond to the designated uses for each zone. Freshwater criteria apply in areas upstream of the Delaware Memorial Bridges (RM 68.75) and the more stringent of the freshwater or marine criteria apply below RM 68.75 to the end of Zone 5 (RM 48.23). Marine criteria apply in Zone 6.

Table 4: Aquatic Life data requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
DO	All	Meet all Zone specific instantaneous minimum, minimum 24-hour average, spawning, and seasonal criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	For instantaneous minimums, less than 1 observation plus 1 confirmatory observation per AU fail the criteria. For 24-hour averages, less than one 24-hour average plus one confirmatory 24-hour average fail the criteria. (see note below)	For instantaneous minimums, at least 20 measurements over the assessment period. For 24-hour averages, at least 20 daily averages over the assessment period.
Temperature	1A-1E	Not to exceed Zone specific increases above ambient temperature	Estimate ambient temperature using data or models. Less than 1 observation plus 1 confirmatory observation per AU fail the criteria, considered in conjunction with the ambient temperature variability or model standard error.	At least 20 samples per AU over the assessment period
	2-6	Not to exceed Zone specific maximum temperatures listed in DRBC Water Quality Regulations, Sections 3.30 and 4.30	Less than 1 daily average plus 1 confirmatory daily average per AU fail the criteria	At least 20 samples per AU over the assessment period
pH	All	Meet Zone specific pH criteria range listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria, unless evidence shows that pH violation are the result of natural conditions and biological communities are not impaired	At least 20 samples per AU over the assessment period

Turbidity	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
TDS	1A-1E, 2-4	Not to exceed Zone specific TDS criteria listed in the DRBC Water Quality Regulations, Sections 3.20, 3.30 and 4.20.2	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least 20 samples per AU over the assessment period
Alkalinity	1E, 2-6	Meet Zone specific criteria range in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least 20 samples per AU over the assessment period
Toxic Pollutants	2-6	Not to exceed criteria noted in DRBC Water Quality Regulations	No more than one (1) exceedence in an AU over a three year window	Available data
	1	Not to exceed EPA recommended CCC criteria	No more than one (1) exceedence in an AU over a three year window	Available data
Biological Monitoring	1A – 1E	6-metric IBI not to fall below 75.6 unit threshold	No more than 30% of samples per AU below the threshold in the assessment period	At least 2 years of data with multiple sites per AU

Note: Determination that the numeric water quality criteria is not met requires at least 2 observations (1 observation plus 1 confirmatory observation) that do not meet criteria.

Public Water Supply

The public water supply use is designated for WQM Zones 1A through 1E, 2, and 3. The parameters used for determining public water supply use support are:

- 1) TDS;
- 2) chlorides;
- 3) toxic substances (human health criteria for systemic toxicants and carcinogens in Zones 2 and 3 only);
- 4) hardness;
- 5) odor;
- 6) phenol;
- 7) sodium (Na); and
- 8) turbidity.

Since this particular use relates to human health, the assessment also takes into account information on actual impacts to the use such as frequent or extended closures of drinking water facilities due to recurring or chronic water quality concerns. Data requirements are shown in Table 5.

Contact Recreation

In the DRBC Water Quality Regulations, the "Recreation" designated use includes all water-contact sports, and thus corresponds to "primary contact" recreation. Some waters, however, are designated as "Recreation - secondary contact" which restricts activities to where the probability of significant contact or water ingestion is minimal, encompassing but not limited to:

- boating,
- fishing,
- those other activities involving limited contact with surface waters incident to shoreline recreation.

Criteria protective of the primary contact designated use are also protective of secondary contact uses. Criteria protective of secondary contact uses are not protective of primary contact uses. Contact recreation data requirements are shown in Tables 6 (Primary Contact) and 7 (Secondary Contact).

Primary

Primary contact recreation applies to Zones 1A-1E, 2, 4 below RM 81.8, and 5 and 6. The parameter used for determining primary contact recreation in Zones 1A-1E is fecal coliform. In addition to fecal coliform, enterococcus bacteria is used to assess primary contact recreation in the tidal Zones 2, 4, 5, and 6. Zone 4 is only assessed against primary contact standards below RM 81.8. The criteria are based on a geometric mean, with samples taken at a certain frequency and location as to permit valid interpretation.

Secondary

DRBC WQM Zones 3 and 4 above RM 81.8 are restricted to secondary contact recreation. Fecal coliform and enterococcus bacteria are used to assess secondary contact recreation. Zone 4 is assessed against secondary contact standards above RM 81.8. The criteria are based on a geometric mean, with samples taken at a certain frequency and location as to permit valid interpretation.

Table 5: Public Water Supply data requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
TDS	1A-1E, 2-3	Not to exceed Zone specific TDS criteria listed in the DRBC Water Quality Regulations, Sections 3.20, 3.30 and 4.20.2	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria (see note below).	At least 20 samples per AU over the assessment period
Hardness	2-3	Not to exceed Zone specific 30-day average criteria listed in DRBC Water Quality Regulations, Section 3.30.2 and 3.30.3	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least three samples in a 30-day period At least 20 samples per AU over the assessment period
Chlorides	2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Section 3.30.2 and 3.30.3	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least two samples in a 15-day period (AU 2) At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
Odor	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	Available data
Phenols	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Section 3.20 and 3.30	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least 20 samples per AU over the assessment period
Sodium (Na)	3 at or above RM 98	Not to exceed 30-day average criteria listed in DRBC Water Quality Regulations, Section 3.30.3	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
Turbidity	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1 observation plus 1 confirmatory observation per AU fail the criteria	At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period

Systemic Toxicants	2-3	Not to exceed criteria listed in DRBC Water Quality Regulations, Section 3.30	No more than one (1) exceedence in an AU over a three year window	Available data
Carcinogens	2-3	Not to exceed criteria listed in DRBC Water Quality Regulations, Section 3.30	No more than one (1) exceedence in an AU over a three year window	Available data
Drinking Water Closures	1A-1E, 2-3	No frequent or extended closures of drinking water facilities due to recurring or chronic water quality concerns	No closures affecting an AU over the assessment period	Administrative closures for drinking water supply over the assessment period. Information from one or more drinking water intake facility per AU.

Note: Determination that the numeric water quality criteria is not met requires at least 2 observations (1 observation plus 1 confirmatory observation) that do not meet criteria.

Table 6: Primary Contact Recreation data requirements and assessment criteria

Parameter	AU ^A	Criteria	Assessment Method	Data Requirements
Fecal coliform	1A-1E,2,4 (below RM 81.8),5,6	Not to exceed Zone specific Fecal coliform criteria listed in the DRBC Water Quality Regulations, Sections 3.20 and 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
Enterococcus	2,4 (below RM 81.8)	Not to exceed Zone and sub-Zone specific Enterococcus criteria listed in the DRBC Water Quality Regulations, Section 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
	5,6	Not to exceed Zone and sub-Zone specific Enterococcus criteria listed in the DRBC Water Quality Regulations, Section 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year

^AWQM Zone 4 is assessed for the parameters below RM 81.8.

Table 7: Secondary Contact Recreation data requirements and assessment criteria

Parameter	AU ^A	Criteria	Assessment Method	Data Requirements
Fecal coliform	3,4 (above RM 81.8)	Not a single geometric mean to exceed 770 / 100 ml	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
Enterococcus	3,4 (above RM 81.8)	Not a single geometric mean to exceed 88 / 100 ml	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year

^AWQM Zone 4 is assessed for the parameters above RM 81.8.

Fish Consumption

The fish consumption designated use applies to all DRBC WQM Zones. The assessment criterion is based primarily on the presence of the Basin states' fish consumption advisories in the mainstem Delaware River and Bay for the assessment period. The presence of fish consumption advisories results in an assessment of "not supporting the designated use". Fish Consumption data requirements are shown in Table 8.

Table 8: Fish Consumption Data requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
Fish Consumption Advisory	1A-1E, 2-6	Not a single fish advisory listed for an AU	Count of the number of fish consumption advisories per AU listed over the assessment period	NY, NJ, DE, and PA fish consumption advisories for the general population based upon the Basin states' fish tissue data

Shellfish Consumption

Shellfish consumption designated use only applies to DRBC WQM Zone 6 (RM 48.2 to the mouth of the Delaware Bay). New Jersey and Delaware assess this use in their coastal waters, using procedures developed by the FDA National Shellfish Sanitation Program (NSSP).

In both states, waters classified for shellfishing may be opened for that use all year round. In some cases, the AU is opened seasonally (typically in winter). In other cases, harvesting may be prohibited due to administrative closures based upon proximity to sewer outfalls. In still other cases, waters may be open to harvesting, but with special treatment of the shellfish, such as transplantation to cleaner waters for a period of time prior to the harvesting. Finally, some waters are closed to shellfish harvesting due to existing water quality concerns. Shellfish Consumption data requirements are shown in Table 9.

Table 9: Shellfish Consumption data requirements and assessment criteria

Parameter	AU ^A	Criterion	Assessment Method	Data Requirements
Shellfish Consumption Classifications	6	No prohibitions and/or year-round closures in an AU. Shellfish waters with special conditions and temporal windows are assessed as supporting but with conditions	Determine the number of shellfish harvesting prohibitions, year-round closures, and limiting conditions per AU listed over the assessment period	DE and NJ shellfish consumption and harvesting advisories, prohibitions, closures, and limiting conditions per AU over the assessment period

^A WQM zone 6 is subdivided into multiple units based on Shellfish Management Directives.

Assessment Results

The following sections provide the 2016 assessment results for the designated uses:

1. Aquatic Life;
2. Public Water Supply;
3. Contact Recreation;
4. Fish Consumption; and
5. Shellfish Consumption.

Aquatic Life

The Aquatic Life Assessment results are presented in Table 10 below. The composite aquatic life assessment for 2016 yields a result of “Not supporting” for all assessment units. It is important to note, however, that this result is largely driven by the requirement to categorize as not meeting criteria any assessment unit with 1 exceedance plus 1 confirmatory exceedance.

Table 10: Aquatic Life Designated Use Assessment Results

Zone (Assessment Unit)	DO	pH	Turbidity	Temperature	TDS	Alkalinity	Toxic Pollutants	Biological Assessment	2016 Assessment	2014 Assessment
1A	+	-	- ^A	N/A ^C	+	N/A	- ^F	+	NS	NS ^E
1B	+	-	+	N/A ^C	+	N/A	- ^F	+	NS	NS ^E
1C	+	- ^A	+	N/A ^C	+	N/A	+ ^F	+	NS ^E	NS ^E
1D	+	- ^A	+	N/A ^C	- ^A	N/A	- ^F	+	NS ^E	NS ^E
1E	+	-	- ^A	N/A ^C	+	- ^A	+ ^F	-	NS	NS
2	- ^A	- ^A	- ^A	- ^B	+	+	+	NC	NS ^E	NS ^E
3	+	+	+	- ^{A, B}	+	+	+	NC	NS ^E	NS ^E
4	+	+	+	- ^{A, B}	N/A ^D	+	+	NC	NS ^E	NS
5	- ^A	+	- ^A	- ^{A, B}	N/A	+	-	NC	NS	NS
6	- ^A	- ^A	- ^A	- ^A	N/A	- ^A	-	NC	NS	NS

Notes:

+ -- The Assessment Unit meets WQC

- -- The AU does not meet WQC

A – Rate of criteria exceedance is below the historical threshold of 10%.

B – Temperature criteria exceedance may be driven, in part, by meteorologic and atmospheric conditions. The proportion of temperature exceedance caused by controllable anthropogenic inputs is unknown at this time.

C – Temperature criteria in Zone 1A through 1E are expressed relative to ambient temperature, but ambient temperature is not defined. We interpret these criteria to be applicable to thermal mixing zones. Therefore, Zones 1A through 1E lack a surface water quality standard for temperature.

D – Criteria expressed relative to background, but background is undefined.

NC – No criteria developed.

E – Based primarily on fewer than 10% exceedances of criteria

F – The Assessment Unit meets (+) or does not meet (-) the most stringent of applicable basin states' standards

ID – Insufficient data to make an assessment

NS – The assessment does not support the designated use

N/A – The parameter is not applicable in this assessment unit

Dissolved Oxygen

Dissolved oxygen (DO) refers to the concentration of oxygen gas incorporated in water. Oxygen enters water both by direct absorption from the atmosphere, which is enhanced by turbulence, and as a by-product of photosynthesis from algae and aquatic plants. Sufficient DO is essential to growth and reproduction of aerobic aquatic life. Oxygen levels in water bodies can be depressed by the discharge of oxygen-depleting materials (measured in aggregate as biochemical oxygen demand, BOD, from wastewater treatment facilities), from the decomposition of organic matter including algae generated during nutrient-induced blooms, and from the oxidation of ammonia and other nitrogen-based compounds.

Table 11 below shows the assessment results for DO for all Zones. All criteria were met in Zones 1A, 1E, 3, and 4. In Zones 1C and 1D, all instantaneous minima criteria were met. Since only daytime spot measurements were made in Zones 1C and 1D, attainment of the 24-hour mean criteria was presumed since all measurements were above (met) that criteria. All seasonal mean criteria were met in Zones 2 through 5. The majority of observations met criteria in Zones 1B, 2, 5, and 6.

Table 11: DO Assessment Results

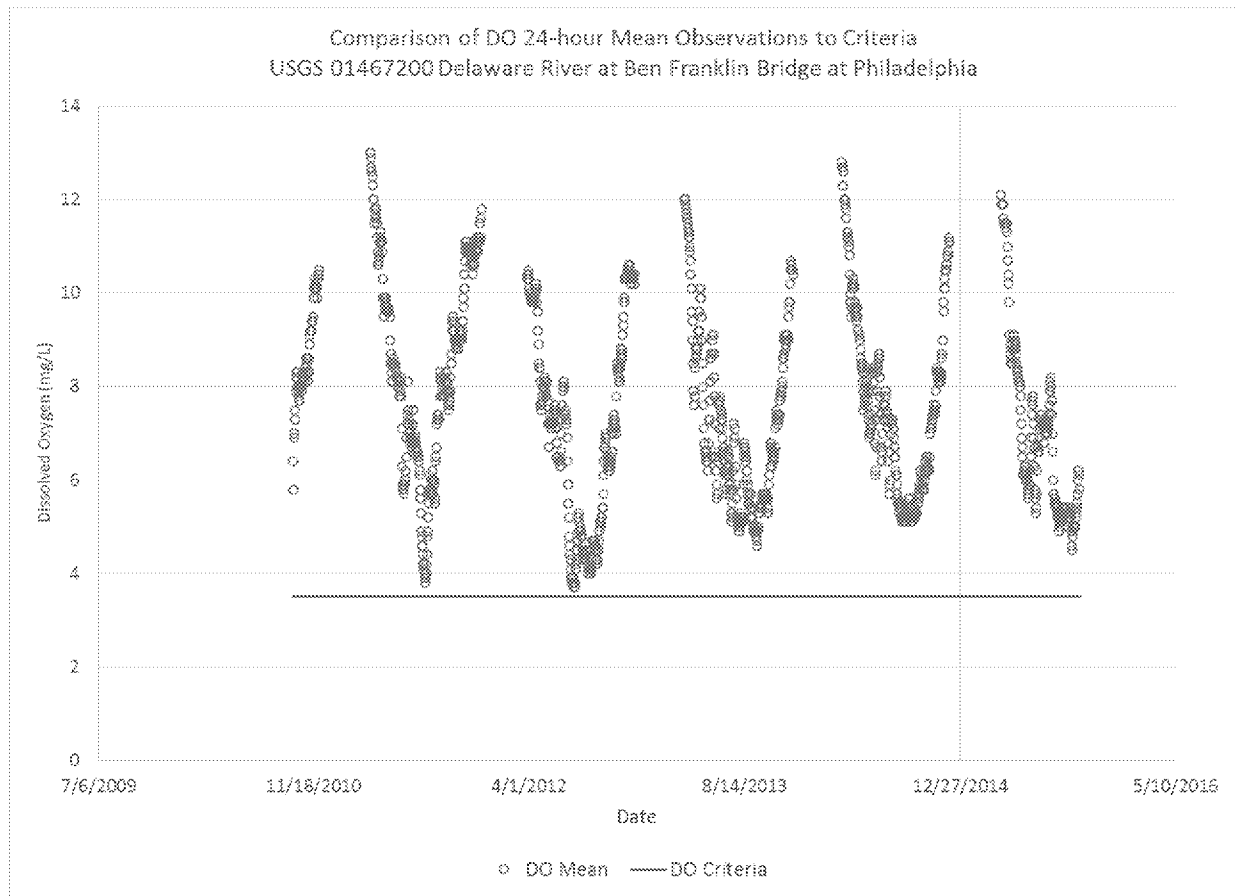
Zone	% Observations Meeting Daily Mean Criteria	% Meeting Seasonal Criteria	% Meeting Instantaneous Minimum Criteria	Primary Data Source(s)	Notes
1A	100%	100% (trout spawning minimum)	100%	<ul style="list-style-type: none">National Park Service continuous monitor at Lordville	Continuous monitor data for 2013 and 2014 only.
1B	100%	N/A	99.8%	<ul style="list-style-type: none">National Park Service continuous monitor at Barryville	No continuous monitor data before October 2012. Majority of data points below criteria are indicated as zero, which is suspect. Actual percentage meeting criteria is likely closer to 100%. May 2015 data removed with consent of NPS.

Zone	% Observations Meeting Daily Mean Criteria	% Meeting Seasonal Criteria	% Meeting Instantaneous Minimum Criteria	Primary Data Source(s)	Notes
1C	100% (presumed)	N/A	100%	<ul style="list-style-type: none"> • SRMP Monitoring • USGS NJ 	Daytime spot measurements only for assessment. Continuous monitor data is available beginning October 2014. Given that this duration covers only a small portion of the assessment window, we did not rely on this data. We did review the available continuous monitor data and it supports that the zone is fully meeting criteria.
1D	100% (presumed)	N/A	100%	<ul style="list-style-type: none"> • SRMP / Lower Delaware Monitoring • USGS (PA & NJ) • PADEP 	Daytime spot measurements only
1E	100%	N/A	100%	<ul style="list-style-type: none"> • USGS 01463500 Delaware River at Trenton NJ • USGS 01458500 Delaware River at Frenchtown NJ 	Frenchtown data began in September 2014

Zone	% Observations Meeting Daily Mean Criteria	% Meeting Seasonal Criteria	% Meeting Instantaneous Minimum Criteria	Primary Data Source(s)	Notes
2	99.0%	100%	N/A	<ul style="list-style-type: none"> USGS 014670261 Delaware River nr Pennypack Woods, PA 	No data before March 2011
3	100%	100%	N/A	<ul style="list-style-type: none"> USGS 01467200 Delaware R at Ben Franklin Bridge at Philadelphia 	
4	100%	100%	N/A	<ul style="list-style-type: none"> USGS 01477050 Delaware River at Chester, PA 	
5	98.5%	100%	N/A	<ul style="list-style-type: none"> USGS 01482800 Delaware River at Reedy Island Jetty, DE 	
6	90.8% (presumed)	N/A	97.9%	<ul style="list-style-type: none"> DRBC Boat Run Delaware Department Of Natural Resources And Environmental Control NJDEP Bureau of Marine Water Monitoring 	Daytime spot measurements only

Determining whether 24-hour criteria were met is most appropriately accomplished by comparing the daily mean DO from continuous monitors, which record data hourly or sub-hourly, and comparing these computed results to the criteria. Where only daytime spot measurements are available, we presumed that if the measured value is less than the 24-hour mean criterion, then the 24-hour mean is also likely to be below (not meet) the criterion. Zones 1D and 6 currently lack continuous water quality meters, and were assessed using daytime spot measurements only. Figure 3 below shows a comparison of daily mean and seasonal mean DO observations at the USGS monitor at the Ben Franklin Bridge (Zone 3) to the 24-hour mean and seasonal criteria.

Figure 3: DO Observations Compared to Criteria



pH

The pH of surface waters has long been recognized as both a natural and human-induced constraint to the aquatic life of fresh and salt water bodies, both through direct effects of pH and through indirect effects on the solubility, concentration, and ionic state of other important chemicals (e.g., metals, ammonia). Among natural waters, both highly alkaline waters and highly acidic waters (like the NJ Pinelands) are known to severely restrict the species of plants and animals that can thrive in particular lakes and streams. Likewise, human alteration of the pH regimen for a water body can alter both the quality of that water and the aquatic life inhabiting that system. Table 12 below shows the assessment results for pH for each Zone.

Table 12: pH Assessment Results

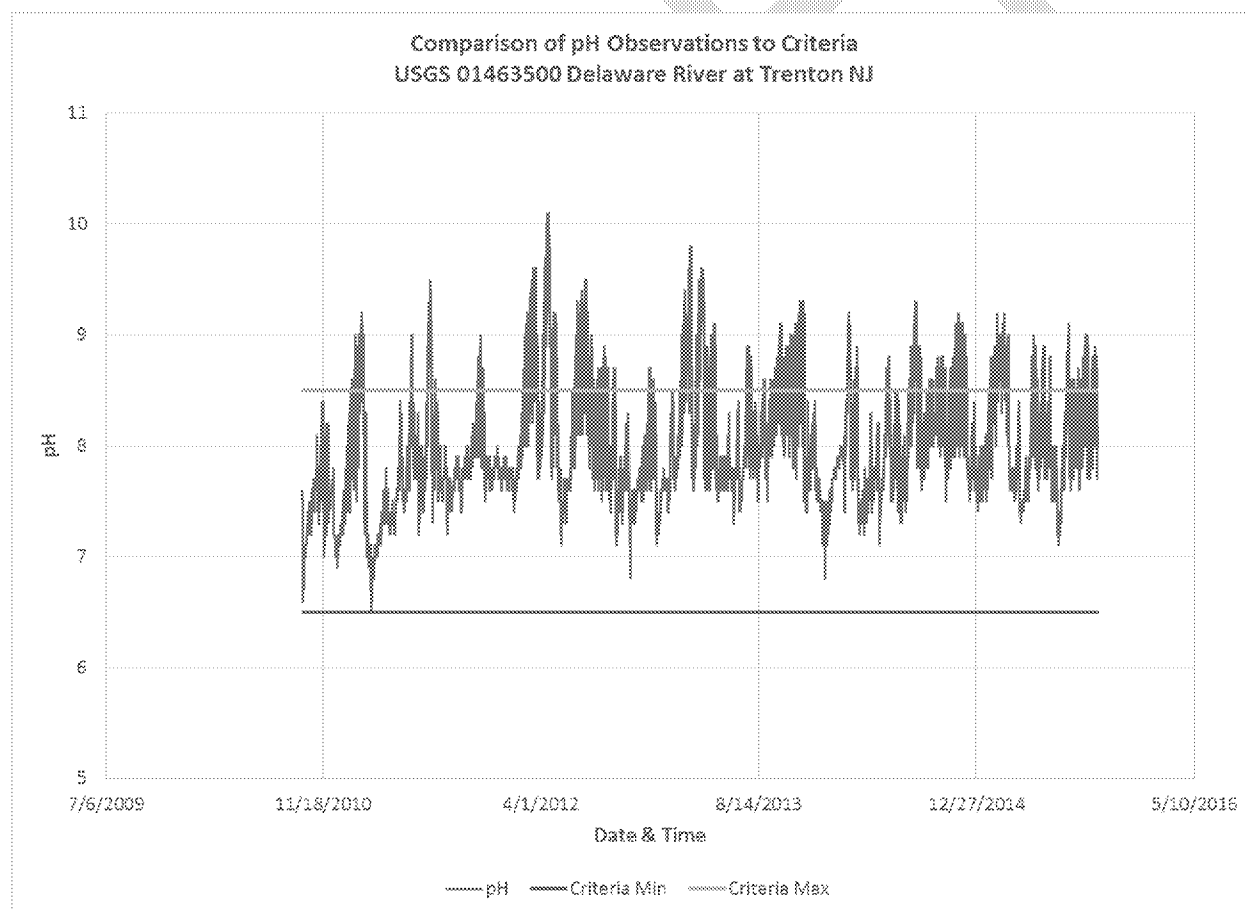
Zone	% Observations or Observations Days Meeting Criteria	Primary Data Source(s)	Notes
1A	70.77%	<ul style="list-style-type: none"> National Park Service continuous monitor at Lordville 	2014 data only. Most violations were higher than the pH maximum (8.5). Only 2 violations observed below the pH minimum (6.5).
1B	62%	<ul style="list-style-type: none"> National Park Service continuous monitor at Barryville 	No data before September 2012
1C	94.78%	<ul style="list-style-type: none"> SRMP Monitoring 	Daytime spot measurements only
1D	95.56%	<ul style="list-style-type: none"> SRMP / Lower Delaware Monitoring USGS PA PADEP 	Daytime spot measurements only.
1E	69.4%	<ul style="list-style-type: none"> USGS 01463500 Delaware River at Trenton NJ 	All violations were higher than the pH maximum (8.5). No violations observed below the pH minimum (6.5). Comparable results at Frenchtown (USGS 01458500) although slightly worse and a limited period of record beginning in September 2014.
2	98.7%	<ul style="list-style-type: none"> USGS 014670261 Delaware River nr Pennypack Woods, PA 	No data before March 2011
3	100%	<ul style="list-style-type: none"> USGS 01467200 Delaware R at Ben Franklin Bridge at Philadelphia 	
4	100%	<ul style="list-style-type: none"> USGS 01477050 Delaware River at Chester, PA 	
5	100%	<ul style="list-style-type: none"> USGS 01482800 Delaware River at Reedy Island Jetty, DE 	
6	98.4%	<ul style="list-style-type: none"> DRBC Boat Run Delaware Department Of Natural Resources And Environmental Control New Jersey Bureau of Marine Water Monitoring 	Daytime spot measurements only

In December 2013, the Commission adopted revised pH criteria applying to all zones of the Delaware River and Bay. That revised criteria requires that pH be between 6.5 and 8.5 inclusive, unless outside this range due to natural conditions.

As shown in Table 12, pH criteria were met in Zones 3, 4, and 5. Criteria for pH were mostly met in Zones 2 and 6. Criteria were routinely violated in Zones 1A, 1B, and 1E. In Zones 1C and 1D, pH assessment is hampered by the lack of continuous monitors. Like DO, pH has a diel cycle due to photosynthesis, with the lowest pH values expected in the early morning hours or pre-dawn, and the highest pH values expected in the mid to late afternoon. Monitoring programs that rely on spot measurements are far more likely to capture daytime high values, and miss pre-dawn low values.

Figure 4 below shows that the upper level criterion (8.5) was routinely violated at the Delaware River at Trenton, NJ. Although the criteria allow exceedances if due to natural conditions, the Commission has not defined what would constitute demonstration of natural conditions. Natural conditions, for the application of pH criteria, should be defined before the next assessment.

Figure 4: pH Observations Compared to Criteria



Turbidity

According to Standard Methods (2005), “Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change in direction or flux level through the sample.” From an observational perspective, water with low turbidity appears clear, while higher turbidity waters are cloudy or muddy. Table 13 below shows the assessment results for each Zone relative to DRBC’s turbidity criteria.

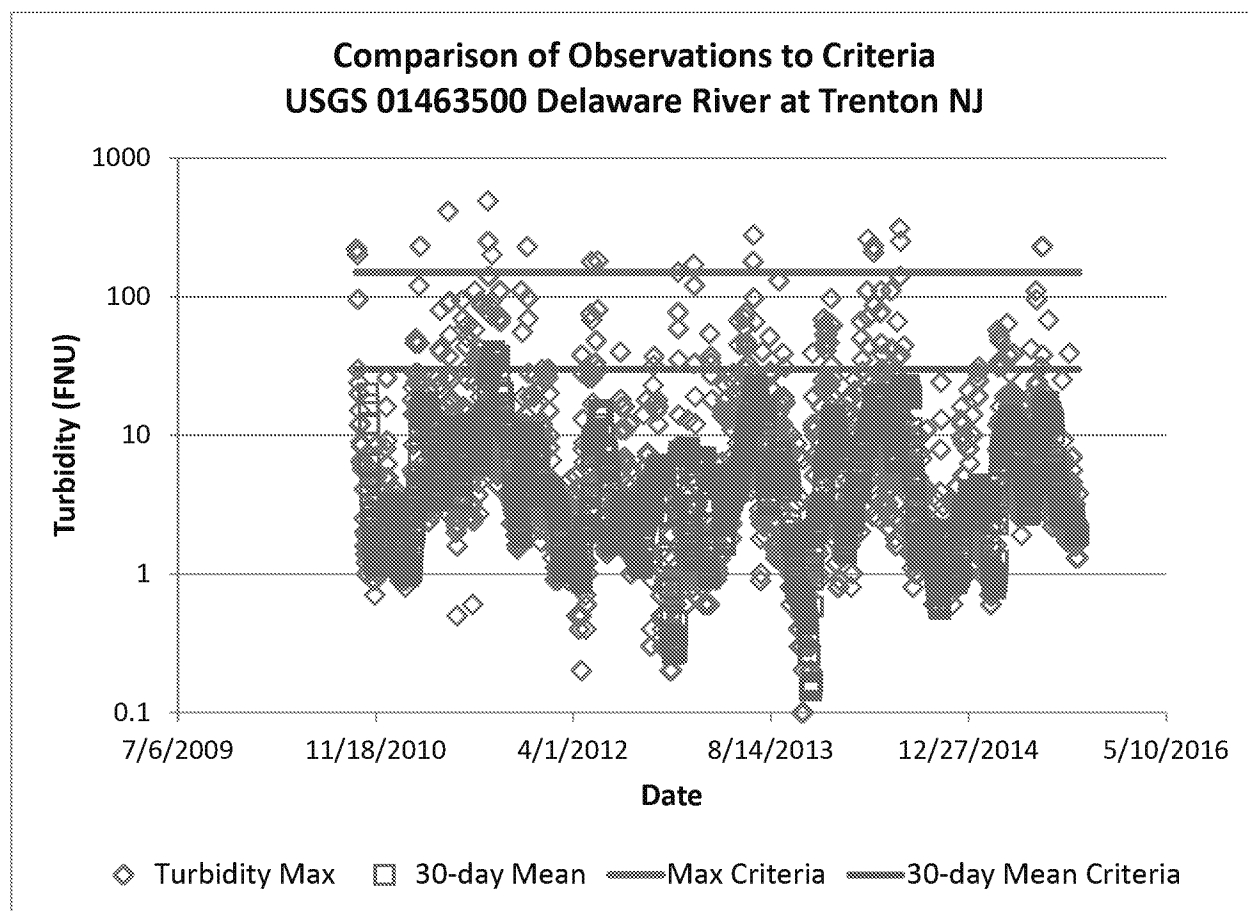
Table 13: Turbidity Assessment Results

Zone	% Observation Meeting Max Criteria	% Meeting 30-day Average Criteria	Primary Data Source(s)	Notes
1A	98.9%	73.7%	<ul style="list-style-type: none"> National Park Service continuous monitor at Lordville 	No data before August 2012
1B	100%	Insufficient Data to Assess	<ul style="list-style-type: none"> SRMP Monitoring 	Continuous monitor data not used at recommendation of owner.
1C	100%	Insufficient Data to Assess	<ul style="list-style-type: none"> SRMP Monitoring 	Daytime spot measurements only. The criteria for 30-day average is less than 20 TU. Although there was insufficient data to assess on a 30-day average basis, 97.6% of all observations were less than 20 TU.
1D	100%	Insufficient Data to Assess	<ul style="list-style-type: none"> SRMP / Lower Delaware Monitoring 	Daytime spot measurements only. The criteria for 30-day average is less than 20 TU. Although there was insufficient data to assess on a 30-day average basis, 98.6% of all observations were less than 20 TU.
1E	98.75%	98.55%	<ul style="list-style-type: none"> USGS 01463500 Delaware River at Trenton NJ 	
2	99.6%	100%	<ul style="list-style-type: none"> USGS 014670261 Delaware River nr Pennypack Woods, PA 	No data before March 2011
3	100%	Insufficient Data to Assess	<ul style="list-style-type: none"> DRBC Boat Run 	Continuous Monitor Data discontinued after December 2011

Zone	% Observation Meeting Max Criteria	% Meeting 30-day Average Criteria	Primary Data Source(s)	Notes
4	100%	Insufficient Data to Assess	<ul style="list-style-type: none"> • DRBC Boat Run 	No Turbidity on USGS Monitor, spot measurements only
5	99.64%	Insufficient Data to Assess	<ul style="list-style-type: none"> • DRBC Boat Run • Delaware Department Of Natural Resources And Environmental Control 	Continuous Monitor Data discontinued after December 2011
6	96.9%	Insufficient Data to Assess	<ul style="list-style-type: none"> • DRBC Boat Run • Delaware Department Of Natural Resources And Environmental Control 	Spot measurements only

Figure 5 below shows daily maximum turbidity compared to the instantaneous maximum criteria and 30-day mean turbidity compared to the 3-day mean criteria at the USGS monitor at Trenton, NJ in Zone 1E.

Figure 5: Turbidity Compared to Criteria in Zone 1E



Temperature

Water temperature is an important factor for the health and survival of native fish and aquatic communities. Temperature can affect embryonic development; juvenile growth; adult migration; competition with non-native species; and the relative risk and severity of disease. Estuary Temperature Criteria are expressed in DRBC regulations by day of year in Zones 2, 3, and 4. In Zones 5 and 6, a single maximum water temperature is specified. Table 14 below shows that water temperature criteria were mostly met, with the greatest number of exceedances occurring in Zones 2 and 4.

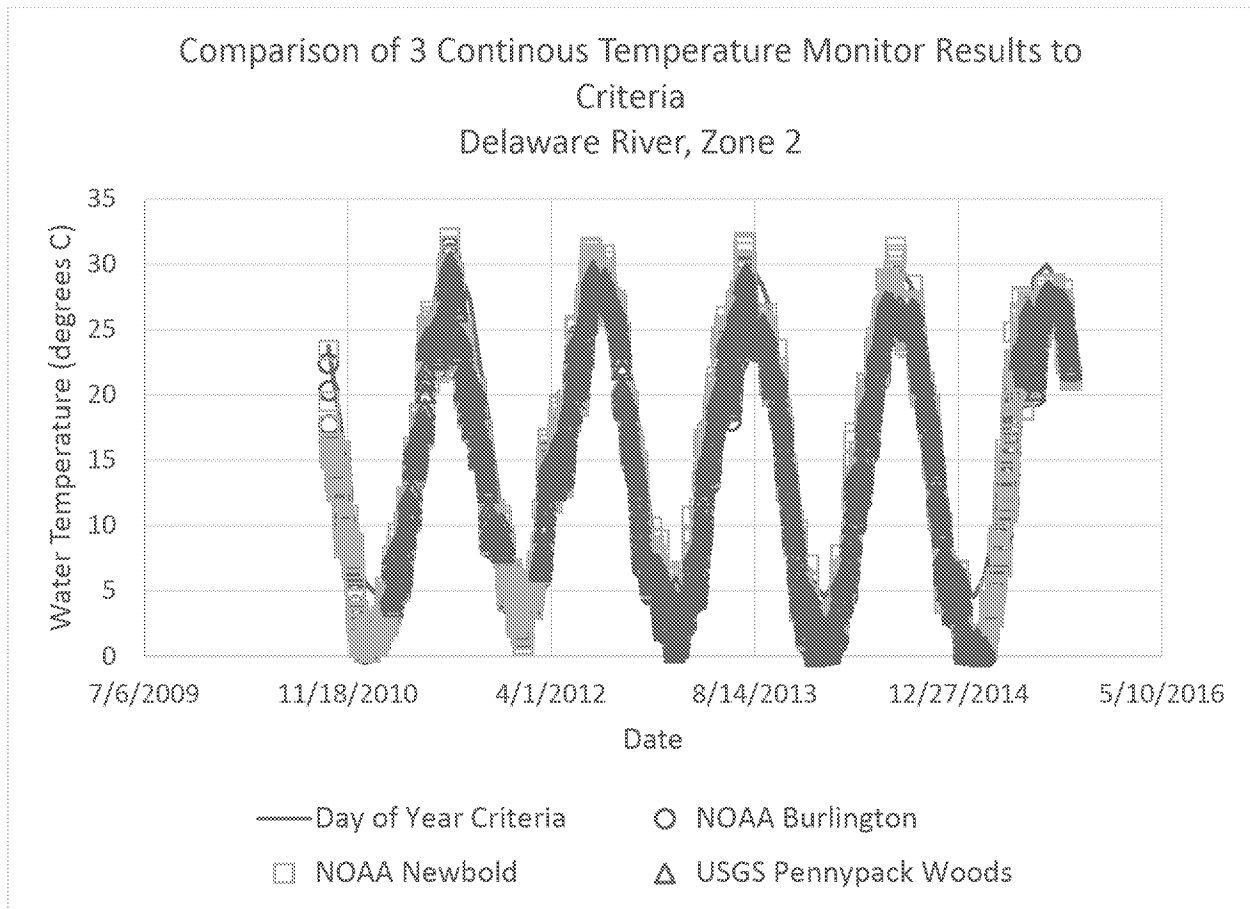
As noted in previous assessments, criteria in Zones 1A through 1E are clearly oriented toward determining compliance of thermal mixing zones for point discharges. Currently, DRBC has no ambient surface water temperature standards in Zones 1A through 1E. In previous assessments, we investigated approaches for assessing surface waters in the non-tidal river against the thermal mixing zone criteria. None of these approaches was workable. The DRBC work plan for 2016 includes the task of developing new temperature criteria for the non-tidal river.

Table 14: Temperature Assessment Results

Zone	% Observation Days Meeting Criteria	Primary Data Source(s)	Notes
1A	Criteria applicable to Heat Dissipation Areas only for Zone 1 AU's		
1B			
1C			
1D			
1E			
2	87.35%	<ul style="list-style-type: none"> • Newbold (NOAA PORTS) • Burlington (NOAA PORTS) • Delaware River nr Pennypack Woods, PA (USGS NWIS) 	NWIS Pennypack Woods site no data before March 2011
3	96.22%	<ul style="list-style-type: none"> • Philadelphia (NOAA PORTS) • Ben Franklin Bridge (USGS NWIS) • Tacony Palmyra (NOAA PORTS) 	Tacony Palmyra temperature discontinued February 2013.
4	92.52%	<ul style="list-style-type: none"> • Marcus Hook (NOAA PORTS) • Chester (USGS NWIS) • Fort Mifflin (USGS NWIS) 	Marcus Hook temperature discontinued July 2015. Fort Mifflin during low flow only (313 observation days during 5 year data window).
5	98.85%	<ul style="list-style-type: none"> • Reedy Island (USGS NWIS) • Delaware City (NOAA PORTS) 	
6	99.18%	<ul style="list-style-type: none"> • Brandywine Shoal (NOAA PORTS) • Lewes (NOAA PORTS) • Ship John Shoal (NOAA PORTS) 	Brandywine Shoal data from July 2011 through October 2012 only.

Figure 6 below shows the comparison of water temperature observations in Zone 2 to the day-of-year temperature criteria. Note that observations in Zone 4 include continuous monitor data from NOAA PORTS monitors at Burlington and Newbold and USGS at Pennypack Woods.

Figure 6: Water Temperature Observations Compared to Criteria in Zone 2



As also noted in previous assessments, atmospheric temperatures and meteorological conditions are strong drivers of water temperature. DRBC previously demonstrated that water temperatures are strongly linked to air temperatures, and that a notable increase in air temperatures is observable between the temperature gradient period (1961-1966) and the current period. At present, we lack the tools to determine which portion of the exceedance is attributable to potentially controllable anthropogenic thermal inputs, and which portion is due to meteorological drivers beyond our control.

Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) reflects the concentration of solids in a water sample capable of passing through a filter (typically 2 μ m) and dried. As an analytical parameter, TDS represents the collective mass of individual constituents, including cations, anions, and dissolved organic material. Studies have shown that high TDS concentrations negatively impact aquatic life and cause shifts in biological communities. In freshwater, TDS is frequently used as an indicator of the anthropogenic burden.

Table 15 below shows the TDS criteria were met in all Zones except 1D. The TDS criteria in Zone 4 is expressed only as a percentage above background, and background in Zone 4 has not been defined. DRBC has no TDS criteria in Zones 5 and 6, presumably because TDS in marine waters is naturally high.

Table 15: TDS Assessment Results

Zone	% Observations Meeting Criteria 500 mg/L	% Observations Meeting Criteria 133% of background	Primary Data Source(s)	Notes
1A	100%	100%	<ul style="list-style-type: none"> • DRBC (SRMP) • NY DECA • PADEP 	
1B	100%	98.8%	<ul style="list-style-type: none"> • DRBC (SRMP) • NY DECA • PADEP 	One apparent violation of 133% of background (90 mg/L) with no confirmatory violation
1C	100%	100%	<ul style="list-style-type: none"> • DRBC (SRMP) 	
1D	100%	98%	<ul style="list-style-type: none"> • DRBC (SRMP) • PADEP • USGS-PAWSC 	
1E	99.2%	99.2%	<ul style="list-style-type: none"> • DRBC (SRMP) • PADEP 	One apparent violation of both criteria, but no confirmatory violation
2	100%	100%	<ul style="list-style-type: none"> • DRBC Boat Run 	
3	100%	N/A	<ul style="list-style-type: none"> • DRBC Boat Run 	Background not defined in regulations for 133% of Background criteria
4	Does not apply	N/A	<ul style="list-style-type: none"> • DRBC Boat Run 	Background not defined in regulations for 133% of Background criteria
5	No Criteria		<ul style="list-style-type: none"> • DRBC Boat Run 	
6			<ul style="list-style-type: none"> • DRBC Boat Run 	

Alkalinity

According to Standard Methods (2005), “alkalinity of a water is its acid-neutralizing capacity. It is the sum of all the titratable bases.” As shown in Table 16 below, alkalinity criteria were met in Zones 2 through 5.

Table 16: Alkalinity Assessment Results

Zone	% Observations Meeting Criteria	Primary Data Source(s)	Notes
1A	No Criteria		
1B			
1C			
1D			
1E	96.7%	<ul style="list-style-type: none">• SRMP / Lower Delaware Monitoring• PADEP	
2	100%	<ul style="list-style-type: none">• DRBC Boat Run	
3	100%	<ul style="list-style-type: none">• DRBC Boat Run	
4	100%	<ul style="list-style-type: none">• DRBC Boat Run• PADEP	One data point, listed as 0, excluded as suspect
5	100%	<ul style="list-style-type: none">• DRBC Boat Run• DNREC	One apparent violation (>100 mg/L) with no confirmatory violation
6	90.3%	<ul style="list-style-type: none">• DRBC Boat Run• DNREC• NJDEP	

Toxic Pollutants

The Delaware River Basin Commission (DRBC) stream quality objectives for human health and aquatic life in the tidal portion of Delaware Basin from the head of tide at Trenton, NJ to the mouth of the Delaware Bay (Zones 2 through 6) reflect current scientific information and harmonize DRBC criteria with basin states’ criteria. DRBC criteria are used in the 2016 assessment for Zones 2 through 6, as described in Methodology for the 2016 Delaware River and Bay Water Quality Assessment Report. DRBC has adopted numeric toxics criteria in Zones 2 through 6. In addition, DRBC has a narrative standard applicable to waters of the Basin requiring that: *“the waters shall be substantially free from ... substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life”*

The DRBC toxics criteria subcommittee recommended, at the November 19, 2014 meeting, a review of DRBC water quality assessment methodology for toxics in Zone 1. To ensure attainment and maintenance of downstream water quality standards and to facilitate consistent and efficient implementation and coordination of water quality-related management actions in shared interstate waters, an assessment methodology based on the most stringent of basin state standards in Zones 1A

though 1E is used in this assessment. Criteria and standards to be used in the assessment of Zone 1 are New Jersey Surface Water Quality Standards, adopted January 18, 2011; Title 25, Chapter 93 Water Quality Standards; NYDEC Part 703: Surface Water and Groundwater Quality Standards and Groundwater Limitations and USEPA National Recommended Water Quality Criteria. In waters protected for public water supply, the most stringent ambient water quality criteria for human health for New York or Pennsylvania are compared to surface water data in Zones 1A and 1B. The most stringent ambient water quality criteria for human health for Pennsylvania or New Jersey is compared to surface water data in Zones 1C, 1D, and 1E.

For waters protected for use by fish and other aquatic life, the most stringent ambient water quality criteria apply. Stream quality objectives for the protection of aquatic life for cadmium, chromium, copper, lead, nickel, silver and zinc are expressed as the dissolved form of the metal. Stream quality objectives for other metals are expressed as the concentration of the total recoverable form of the metal. For those stream quality objectives whose numerical value is related to hardness (cadmium, chromium III, copper, nickel silver and zinc), the actual criteria numeric value is computed with site-specific paired hardness measured concurrently with the toxic analytical parameter. When concurrent data is not available, median site-specific hardness measured at other times or at the nearest interstate control point (ICP) may be used. Where multiple sources of hardness data are available, the assessment considers the weight of evidence for multiple derivations of the criteria.

For those stream quality objectives whose numerical value is related to pH (such as pentachlorophenol), site-specific paired pH measured concurrently with the toxic analytical parameter or median site-specific pH measured at other times or at the nearest interstate control point (ICP).

Data Quantity and Quality

Water quality monitoring data from multiple organizations (DRBC, DNREC, NYSDEC, NJDEP, PADEP and USGS) are included in the 2016 assessment. This assessment includes data from DRBC enhanced studies of PAHs and pesticides in the Delaware Estuary (Zones 2 to 6) as well as non-tidal (Zone 1) and tidal (Zone 5) studies of metals. Toxic pollutants data are collected using EPA approved or equivalent methods with the level of monitoring varying by Zone and toxic pollutant. DRBC toxics pollutants monitored during the timeframe of the assessment are listed in Appendix C. Criteria monitored to protect water taste and odor fish for human ingestion are listed in Appendix D.

Metals

Use of Freshwater or Marine Stream Quality Objectives

DRBC regulations include aquatic life toxics criteria for fresh and marine waters. As a policy, freshwater criteria apply in all areas of the estuary upstream of the Delaware Memorial Bridges. In the main stem Delaware River below the Delaware Memorial Bridges and above Liston Point (RM 48.2, the downstream limit of Zone 5) and in tributaries up to the 5ppt isopleth at 7Q10, the more stringent of the freshwater or marine criteria will apply. Downstream from Liston Pt., the marine criteria are used.

- In addition, site-specific paired salinity measured between RM 69.7 and 48.2 concurrently with toxic analytical parameters confirm that, when exceedances of freshwater objectives occur, ambient conditions are < 5 ppt salinity and when exceedances of marine objectives occur, ambient conditions are ≥ 5 ppt salinity.

Dissolved Metals

For criteria expressed as the dissolved form of the metal, assessment of monitoring data is as follows:

- In assessment Zones with dissolved metals data collected, direct comparison to DRBC dissolved criteria is the preferred assessment.
- In assessment Zones with only total metals data collected (as noted in Appendix D), comparison of total metals data to estimated total metals criteria using conversion factors listed in “Revised Procedure for Converting Total Recoverable Water Quality Criteria for Metals to Dissolved Criteria” <http://www.state.nj.us/drbc/regs/critmetals.pdf>.

Hardness Dependent Stream Quality Objectives

Some criteria require hardness values to compute the actual criteria numeric value. In these cases, toxics data from ambient water are compared to stream quality objectives using hardness values listed in DRBC Water Quality Regulations for Zones 2 through 5 (i.e., 74 mg/L as CaCO₂).

- An additional comparison is conducted as part of this assessment with site-specific paired hardness measured concurrently with toxic analytical parameters.
- For Zone 1 assessments, the actual criteria numeric value is computed with site-specific paired hardness measured concurrently with the toxic analytical parameter and the measured ambient water concentrations of copper are also compared to criteria numeric values calculated with median, minimum and maximum hardness values measured at the nearest interstate control point (ICP).

Polycyclic aromatic hydrocarbons (PAHs)

In a 2012 DRBC pilot survey of PAHs analyzed by EPA Method 525.2 LL using both low level SCAN analysis and low level SIM analysis to achieve reporting levels of 0.25 to 5 ng/L, single date measurements of benz[a]anthracene concentration in surface water samples from two sites at 3.82 and 8.82 ng/L and benz[a]pyrene concentration from one site at 6.16 ng/L exceed the DRBC freshwater objective for human health fish and water ingestion of 3.8 ng/L. The limited data is insufficient to assess exceedance frequency of greater than once per three years for PAHs. Using EPA Method 8920D, no exceedances of PAHs are observed in Zones 2 through 6 greater than the 1 to 5 µg/L detection limits reported for PAHs analyzed by GC/MS. Sensitivity of the analytical method is insufficient to assess if all PAH stream quality objectives for the Delaware River were met.

Using the Relative Potency Factor (RPF) approach for assessing carcinogenic risk from PAH mixtures by summing PAH concentrations for anthracene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene and pyrene adjusted by relative potency factors (RPF), a potential risk is indicated at sites sampled in Zones 2, 3 and 4 from PAH mixtures in surface water. DRBC water quality assessment methodology does not currently include assessment for PAH mixtures.

Coordination among basin states and agencies should continue to ensure the use of the most appropriate analytical and assessment methodologies for PAHs.

Whole Effluent Toxicity

Based on sampling in 2012, measured Whole Effluent Toxicity (WET) endpoints at eleven sites in the main stem of the Delaware River clearly did not indicate chronic toxicity to the tested species. However,

three sites in main stem DRBC Water Quality Zone 5 warranted further assessment to confirm the existence and persistence of toxicity and to evaluate potential sources (chemical causes) of observed toxicity. (<http://www.state.nj.us/drbc/quality/toxics/wet/>) As a follow-up to the 2012 screening level toxicity tests, confirmatory samples were collected in 2013 from DRBC Water Quality Zone 5 in the main stem Delaware River. Based on the test species tested and the measured endpoints, the water sampled did not confirm chronic toxicity to aquatic life at a biologically significant level.

Exceedances in Zones 2 through 6

Data showed multiple exceedances in Zone 5 of the chronic freshwater criterion for **copper** using the DRBC regulatory hardness of 74 mg/L CaCO₃ in the hardness based criteria equation but not more than one exceedance in three years when site specific hardness are used. Multiple exceedances of DRBC acute and chronic marine stream quality objectives were observed for **copper** in Zones 5 and 6. Assessment is complicated by factors such as field sampling and analytical issues with contamination, the applicability of DRBC's freshwater or marine criteria, a need to assess revisions to the current freshwater and marine criteria, and the influence of other water quality attributes that influence the partitioning and toxicity of copper.

Coordination among basin states and agencies should continue to ensure the use of the most appropriate methods and procedures for the conduct of monitoring studies for copper in the Basin, and the harmonization of water quality criteria and assessment methodologies in all Zones.

Data showed multiple exceedances of **aluminum** acute and chronic freshwater objectives for the support of aquatic life in Zone 4.

Exceedances were found in Zones 2 through 5 of human health objectives (carcinogens) for pesticides: DDD; DDE; DDT and Dieldrin in a 2012 low detection limit study using High Resolution GC/MS methods. Surface water was collected only once (a single day) which is insufficient to assess if stream quality objectives for the Delaware River were met.

Exceedances were found in Zone 4 and 5 of human health objectives (carcinogens) for the pesticide heptachlor epoxide in a 2012 low detection limit study using a High Resolution GC/MS method. Surface water was collected only once (a single day) which is insufficient to assess if stream quality objectives for the Delaware River were met.

Exceedances in Zone 1

Data showed exceedances for the following recommended water quality criteria for the support of aquatic life:

- Exceedances of acute and chronic criteria freshwater objectives for the support of aquatic life in Zone 1 for **aluminum**.
- Exceedances of acute and chronic criteria for **cadmium** freshwater objectives for the support of aquatic life in Zone 1B if J flagged data and samples with hardness < 25 mg/L are include in the assessment. No impairment with unflagged data.
- Exceedances of acute and chronic freshwater objectives for the support of aquatic life for dissolved **copper** were reported two times in Zone 1A and one time in Zone 1B, two acute

exceedances and six chronic exceedances in Zone 1D computed with paired site specific hardness measured concurrently with the toxic analytical parameter and compared to numeric criteria values calculated with hardness measured at the nearest interstate control point (ICP). The apparent exceedances are low in both frequency and magnitude. For total copper measurements compared to total copper criteria (using conversion factors) one exceedance in Zone 1D and one in Zone 1E are observed.

- Exceedances of human health objectives (systemic) for mercury in Zone 1B.
- Exceedances of human health objectives (carcinogens) for total PCB in Zones 1A, 1B, 1D and 1E. PCB were not monitored in Zone 1C.

Biological Assessment

Biological assessment results indicate reference-quality invertebrate communities in Zones 1A, 1B, 1C, and 1D. This includes “attaining” scores in the thermally altered upper mainstem Delaware River between Hancock and Callicoon (i.e., the upper portion of Zone 1A). It is important to note that the “background” rate of scores below 75.6 in reference reaches of the Delaware River is 10%.

Below the Lehigh River in Zone 1E (as was seen in past assessment cycles) 40% of the invertebrate samples fell below the impairment threshold (6 of 15 samples). For the interim methodology, DRBC has defined “impairment” as greater than 30% of sampling falling below the threshold (see Table 17). Therefore, Zone 1E is listed as not meeting the biocriteria for the assessment period.

To maximize the utility of the biological data, 2010 data collected outside the data window was included in this assessment.

Table 17: Summary of Biological Assessment Results

Zone	Years of Data	Stations per Assessment Unit	% of samples in time window w/ 6-metric IBI < 75.6
1A	2 (2010, 2012)	4	0%
1B		3	17%
1C		4	13%
1D		5	20%
1E		7	40%

Public Water Supply

The public water supply designated use is assessed through evaluation of TDS, hardness, chlorides, odor, phenols, sodium, turbidity, systemic toxicants, carcinogens, and administrative drinking water closures.

Table 18 below shows the Public Water Supply assessment results for the 2016 assessment. Additional detail on each evaluation is provided in the subsequent sections.

Table 18: Public Water Supply Designated Use Assessment Results

Zone (AU)	TDS	Hardness	Chlorides	Odor	Phenols	Sodium	Turbidity	Systemic Toxicants	Carcinogens	Drinking water closures	2016 Assessment	2014 Assessment
1A	+	N/A	N/A	ID	ID	N/A	- ^A	+	+	+	NS ^B	NS ^B
1B	+	N/A	N/A	ID	+	N/A	+	+	+	+	S	NS ^B
1C	+	N/A	N/A	ID	ID	N/A	+	+	+	+	S	S
1D	+	N/A	N/A	ID	ID	N/A	+	+	+	+	S	S
1E	+	N/A	N/A	ID	ID	N/A	- ^A	+	+	+	NS ^B	NS ^B
2	+	+	+	ID	+	N/A	- ^A	+	+	+	NS ^B	NS ^B
3	+	+	+	ID	+	+	+	+	+	+	S	NS ^B

Notes:

+ -- The Assessment unit meets WQC

- -- The Assessment unit does not meet WQC

A – Rate of criteria exceedance is below the historical threshold of 10%.

B – Based primarily on fewer than 10% exceedances of criteria

ID – Insufficient Data

N/A – Not applicable (no criteria in this assessment unit)

S – The use is supported in this Assessment Unit

NS – The use is not supported in this Assessment Unit

TDS

A description of TDS and assessment against the TDS criteria are presented under the Aquatic Life designated use in the previous section.

Hardness

Hardness is an integrated measure of divalent metallic cations. Measuring hardness in source water provides an indication of whether water softening will be desirable either in drinking water processing or in the finished drinking water at the point of use. Table 19 below shows that hardness criteria were met in all samples in Zones 2 and 3, where hardness criteria have been adopted.

Table 19: Hardness Assessment Results

Zone	% Observations Meeting Criteria	Primary Data Source(s)	Notes
1A	No Criteria		
1B			
1C			
1D			
1E			
2	100% (presumed)	<ul style="list-style-type: none">DRBC Boat Run	No individual observation exceeded criteria, therefore, attainment of 30-day mean criteria is presumed
3	100% (presumed)	<ul style="list-style-type: none">DRBC Boat Run	
4	Use not applicable in this Zone		
5			
6			

Chlorides

Chloride is one of the major inorganic ions in water and wastewater, and can impart a salty taste to drinking water at elevated concentrations. Chloride criteria are expressed as a 15-day mean in Zone 2 and a 30-day mean in Zone 3. Although sequential daily measurements are not made as part of routine surface water monitoring programs, no individual observation exceeded the numerical criteria (as shown in Table 20 below), therefore 100% attainment of the criteria is presumed.

Table 20: Chlorides Assessment Results

Zone	% Observations Meeting Criteria	Primary Data Source(s)	Notes
1A	No Criteria		
1B			
1C			
1D			
1E			
2	100% (presumed)	<ul style="list-style-type: none"> DRBC Boat Run 	No individual observation exceeded criteria, therefore, attainment of 15-day mean criteria is presumed
3	100% (presumed)	<ul style="list-style-type: none"> DRBC Boat Run 	No individual observation exceeded criteria, therefore, attainment of 30-day mean criteria is presumed
4	Use not applicable in this Zone		
5			
6			

Odor

No odor data was indicated in any of the data sets reviewed. Therefore, no assessment against odor criteria was made.

Phenols

One attempted observation of phenol was made in Zone 1A and was not-detected. In Zone 1B, 20 attempted observations of phenol were made, with all results below criteria or not-detected. No data was found for Zones 1C, 1D, or 1E. In Zone 2, 28 attempted observations of phenol were made, all not-detected. In Zone 3, 17 attempted observations of phenol were made, all not-detected. The public water supply use does not apply to Zones 4, 5, or 6 (although phenol observations were attempted, nearly all not-detected).

Sodium

A criterion for sodium exists only in Zone 3. A review of all available data shows 68 observations of sodium in Zone 3 with all values were below the 30-day mean criterion of 100 mg/L. Although the spacing of the data did not support computing a 30-day mean, since all values were below 100 mg/L, attainment of this criterion is presumed.

Turbidity

A detailed discussion of the turbidity assessment is provided in the Aquatic Life section of this report.

Systemic Toxicants

Systemic toxicants affect the entire body or many organs rather than a specific site. For example, cyanide is a systemic toxicant that can affect every cell and organ in the body by interrupting oxygen exchange by cells. Stream quality objectives for systemic toxicants are established if a reference dose (RfD) exists in EPA's Integrated Risk Information System (IRIS). Public water supply use is supported in Zones 1, 2, and 3 (Table 18, with additional detail in Appendix C4). Exceedances of human health objectives (systemic) for mercury were found in Zone 1B.

Carcinogens

Carcinogens are substances that act directly in causing cancer. This may be due to the ability of the substance such as dioxins/furans to damage the genome or to disrupt cellular metabolic processes. Stream quality objectives for carcinogenic toxicants are established if a cancer potency factor (CPF) is available and the substance is classified as a carcinogen in EPA's Integrated Risk Information System (IRIS). Based on limited data on certain parameters, public water supply use is supported in Zones 1, 2, and 3 (Table 18, with additional detail in Appendix C3). Exceedances were found in Zones 2 and 3 of human health objectives (carcinogens) for pesticides: DDD; DDE; DDT and Dieldrin in a 2012 low detection limit study using High Resolution GC/MS methods. Surface water was collected only once (a single day) which is insufficient to assess if stream quality objectives for the Delaware River were met. Exceedances of human health objectives (carcinogens) for total PCBs were found in Zones 1 A, 1B, 1D and 1E. PCBs were not monitored in Zone 1C.

Polycyclic aromatic hydrocarbons (PAHs)

In a DRBC pilot survey of PAHs analyzed by EPA Method 525.2 LL using low level analysis to achieve reporting levels of 0.25 to 5 ng/L, single date measurements of benz[a]anthracene concentration in surface water samples from two sites at 3.82 and 8.82 ng/L and benz[a]pyrene concentration from one site at 6.16 ng/L exceed the DRBC freshwater objective for human health fish and water ingestion of 3.8 ng/L. The limited data is insufficient to assess exceedance frequency of greater than once per three years for PAHs.

Using the Relative Potency Factor (RPF) approach for assessing carcinogenic risk from PAH mixtures by summing PAH concentrations for anthracene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene and pyrene adjusted by relative potency factors (RPF), a potential risk is indicated at sites sampled in Zones 2, 3 and 4 from PAH mixtures in surface water. DRBC water quality assessment methodology does not currently include assessment for PAH mixtures. Coordination among basin states and agencies should continue to ensure the use of the most appropriate assessment methodologies for PAHs.

Polychlorinated Biphenyls (PCBs)

Exceedances of human health objectives (carcinogens) for total PCB in Zones 1A, 1B, 1D and 1E are based on a stream quality objective with both a drinking water and fish consumption component. Since exposure to PCB occurs primarily by ingesting fish, PCB exceedances are incorporated as fish

consumption advisories under fish consumption designated use. Monitoring and assessment of PCBs in Zones 2 through 6 is incorporated in establishing Total Maximum Daily Load (TMDL) for PCB in the Delaware Estuary.

Maximum Contaminant Levels

Maximum contaminant levels to be applied as human health stream quality objectives in Zones 2 and 3 were not exceeded.

Emerging Contaminants

Emerging contaminants are unregulated substances that have entered the environment through human activities. Current regulatory approaches are inadequate to address these contaminants and the increasing public concern over their environmental and human health implications. Emerging contaminants have historically not been routinely monitored therefore limited information is available on past trends. A pilot survey of emerging contaminants in the main stem of the tidal Delaware River ambient waters in 2007, 2008 and 2009 detected pharmaceuticals, personal care products, perfluorinated compounds, hormones, sterols, nonyl phenols and polybrominated diphenyl ethers at levels comparable to similar compounds and concentrations measured in occurrence studies of ambient water in other urban areas (<http://www.nj.gov/drbc/library/documents/contaminants-of-emerging-concernAug2013rev.pdf>). Assessment priorities in the tidal River include further characterization of persistent and bioaccumulative perfluorinated compounds and a more comprehensive evaluation of potential ecological effects from pharmaceuticals in the estuary. Benchmark values for environmental safety are needed and in some cases water quality criteria may need to be derived for some emerging contaminants to facilitate future water quality assessment.

Drinking Water Closures

For the Assessment Period, there were no administrative closures to drinking water intakes as a result of water quality issues or violations.

Contact Recreation

The DRBC water quality regulations sub-divide Zone 4 for bacteria criteria. The upper portion of Zone 4, above River Mile 81.8, is designated as secondary contact recreation only, while the lower portion of Zone 4, below River Mile 81.8, is designated for both primary and secondary contact recreation. Primary contact recreation is supported in all applicable Zones, except Zone 4 below RM 81.8, where there is insufficient data. Secondary contact recreation is supported in Zones 3 and 4. As shown in Table 21, primary and secondary contact uses were supported in all Zones, except for the lower portion of Zone 4, where insufficient data were available.

Where bacterial counts were present above the quantification limit, we assumed count equal to the quantification limit (if reported) or assumed a count of 600 colonies per 100 mL if the quantification limit was not reported. Where the bacterial count was not detected, we assumed a count equal to the detection limit. Because the geometric mean is defined as the n th root of the product of n numbers, this computation becomes problematic with high numbers of observations ($n > 255$). In Zone 6, where approximately 1000 observations were available, we compared the mean count to criteria, assuming

that the mean would be higher than the geometric mean. If the mean count was lower than criteria, we presume that the geometric mean would also be lower than criteria.

Table 21: Primary and Secondary Contact Recreation Assessment Results

AU	Fecal Coliform		Enterococcus		2016 Assessment	2014 Assessment
	Primary	Secondary	Primary	Secondary		
1A	ID	ID	N/A	N/A	ID	S
1B	+	+	N/A	N/A	S	S
1C	+	+	N/A	N/A	S	S
1D	+	+	N/A	N/A	S	S
1E	+	+	N/A	N/A	S	S
2	+	+	+	+	S	NS
3	N/A	+	N/A	+	S	S
4 (> RM 81.8)	N/A	+	N/A	+	S	S
4 (< RM 81.8)	ID	ID	ID	ID	ID	ID
5	+	+	+	+	S	S
6	+	+	+	+	S	S

Notes:

+ -- The Assessment Unit meets WQC

- -- The Assessment Unit does not meet WQC

ID – Insufficient Data

N/A – Not applicable (no criteria in this assessment unit)

S – The use is supported in this Assessment Unit

NS – The use is not supported in this Assessment Unit

Fish Consumption

The fish consumption designated use applies to all DRBC WQM Zones. The assessment criterion is based primarily on the presence of the Basin states' fish consumption advisories in the mainstem Delaware River and Bay for the assessment period. The presence of fish consumption advisories results in an assessment of "not supporting the designated use".

The following fish advisories reports were used:

State	Fish Consumption Advisory Link
Delaware	http://www.dnrec.delaware.gov/fw/Fisheries/Pages/Advisories.aspx
New Jersey	http://www.state.nj.us/dep/dsr/fishadvisories/2013-final-fish-advisories.pdf
Pennsylvania	http://fishandboat.com/fishpub/summary/sumconsumption.pdf
New York	http://www.health.ny.gov/environmental/outdoors/fish/health_advisories/regional

Table 22 below provides a summary of the consumption advisories issued by the states. For each assessment unit, advisories were issued. There is no assessment unit without an advisory, so the use is not supported in any zone.

It is important to note that the table below provides a summary of consumption advisories only to determine the presence or absence of advisories. In most cases, the actual advisories issued by the respective states are much more detailed. Users should consult the advisories directly for health information regarding consumption of caught fish. Actual State issued advisories *may* differ from Table 22 in several ways, including:

1. Different advisories may be issued for specific subpopulations;
2. Different advisories may be issued for subsections of the water quality management zones;
3. Specific recommendations may be provided for preparation of fish to reduce exposure to contaminants;
4. Species with no restrictions may not be listed in Table 22, as these do not contribute to the total count of advisories for assessing achievement of criteria. However, anglers should be aware of species with no recommended restrictions on consumption.

Polychlorinated Biphenyls (PCBs)

The violation of criteria indicated by the presence of fish consumption advisories is further supported by the presence of measureable PCB concentrations in the water column in excess of the surface water quality standard. Twenty-two main stem channel sites in the tidal Estuary were sampled in September 2012 for PCBs, and analyzed using EPA method 1668 Rev A. Sampling stations were located from Biles Channel near Trenton NJ, to the ocean boundary between Cape May and Lewis. Whole water samples were analyzed for all 209 PCB congeners. Total PCB concentrations range from approximately 200 pg/L, at the ocean boundary, to a maximum of 9,600 pg/L in Zone 5, and decreasing to approximately 3,000 pg/L in Zone 2. All PCB concentrations exceed the former and current PCB water quality criteria for the protection of human health from carcinogenic effects at 16 pg/L.

EPA approved a total maximum daily load (TMDL) for PCBs for Zones 2 through 5 in December 2003, and a second PCB TMDL for Zone 6 in December 2006.

Table 22: Fish Consumption Advisory Summary

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
DELAWARE											
All Finfish	PCBs, Dioxins and furans, Dieldrin									1/year State line to C&D Canal	
Weakfish (all sizes), Bluefish (14 inches or less)	PCBs										12/year C&D Canal to mouth of bay
Bluefish (greater than 14 inches)	PCBs, Mercury										1/year C&D Canal to mouth of bay
Striped Bass, White Perch, American Eel, White Catfish, Channel Catfish	PCBs										2/year C&D Canal to mouth of bay
NEW JERSEY											
Smallmouth Bass	Not listed			1/week	1/week	1/week					
White Sucker	Not listed			1/month	1/week	1/week					
Largemouth Bass	Not listed					No restrictions	1/month	1/month	1/month		
Walleye	Not listed			1/week	No restrictions						
American Eel	Not listed			1/month	1/month	1/month	1/year	1/year	1/year		1/year
Channel Catfish	Not listed			No restrictions	No restrictions	4/year	1/year	1/year	1/year		1/year
White Catfish	Not listed				1/week		1/month	1/month	1/month		1/year
Striped Bass	Not listed					4/year	4/year	4/year	4/year		1/year
White Perch	Not listed						4/year	4/year	4/year		1/year
All Finfish	Not listed									1/year (state line to C&D)	

										canal)	
Bluefish - larger than 24 inches or 6 lbs.	Not listed										Do Not Eat
Bluefish - smaller than 24 inches or 6 lbs.	Not listed										1/year
Striped Bass, White Perch, American Eel, Channel Catfish, White Catfish	Not listed										1/year
Weakfish	Not listed										1/week
NEW YORK											
No advisories for the mainstem Delaware River, although advisories are listed for Cannonsville and Pepacton Reservoirs											
PENNSYLVANIA											
Smallmouth Bass	Mercury	1/month	1/month	1/month	1/month	1/month					
Rock Bass	Mercury	2/month	2/month	2/month	2/month	2/month					
American Eel	Mercury	2/month	2/month	2/month	2/month	2/month					
	PCBs						Do Not Eat	Do Not Eat	Do Not Eat		
Carp	PCBs						6/Year	6/Year	6/Year		
White Perch, Flathead Catfish, Channel Catfish	PCBs						1/month	1/month	1/month		
Striped Bass (Over 28 inches)	PCBs						1/month	1/month	1/month		
Advisories in Place?		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Shellfish Consumption

Shellfish consumption, as a DRBC designated use, only applies to DRBC WQM Zone 6. In the latest shellfish spatial data from the states, the state of Delaware classifies its designated shellfish waters within Delaware Bay as falling into the following two categories:

- Approved (assumed)
- Prohibited

New Jersey classifies shellfish waters as falling into the following categories:

- Approved
- Prohibited
- Seasonal (Nov to Apr)
- Special Restricted
- Suspended Harvesting

Figure 7 indicates the current DE and NJ classifications for shellfish in Zone 6. Table 23 lists a summary of current DE and NJ classifications areas. Since sub-area shapes and dimensions have changed, direct comparison with the 2014 assessment is not possible.

For the current 2016 assessment, approved harvesting areas were considered to be supporting (S) the use. Prohibited waters were considered to be not supporting (NS) the use. AUs classified as special restricted and seasonally restricted are considered to be supported, but with special conditions (SS). Note, however, that the states of DE and NJ do not list all prohibited or provisionally approved waters as impaired waters, as not all restrictions on shellfish harvesting are due to water quality issues (see the respective state Integrated Assessment reports for further information).

In total for the 2016 assessment, 616 mi² are in full support (82.4% of zone 6), 35.4 mi² are supporting with special conditions (4.7%), and 96.1 mi² are not supporting the shellfish consumption use (12.9%).

Figure 7: Shellfish Consumption Classifications designated by New Jersey and Delaware for the Delaware Bay (DRBC WQM zone 6)

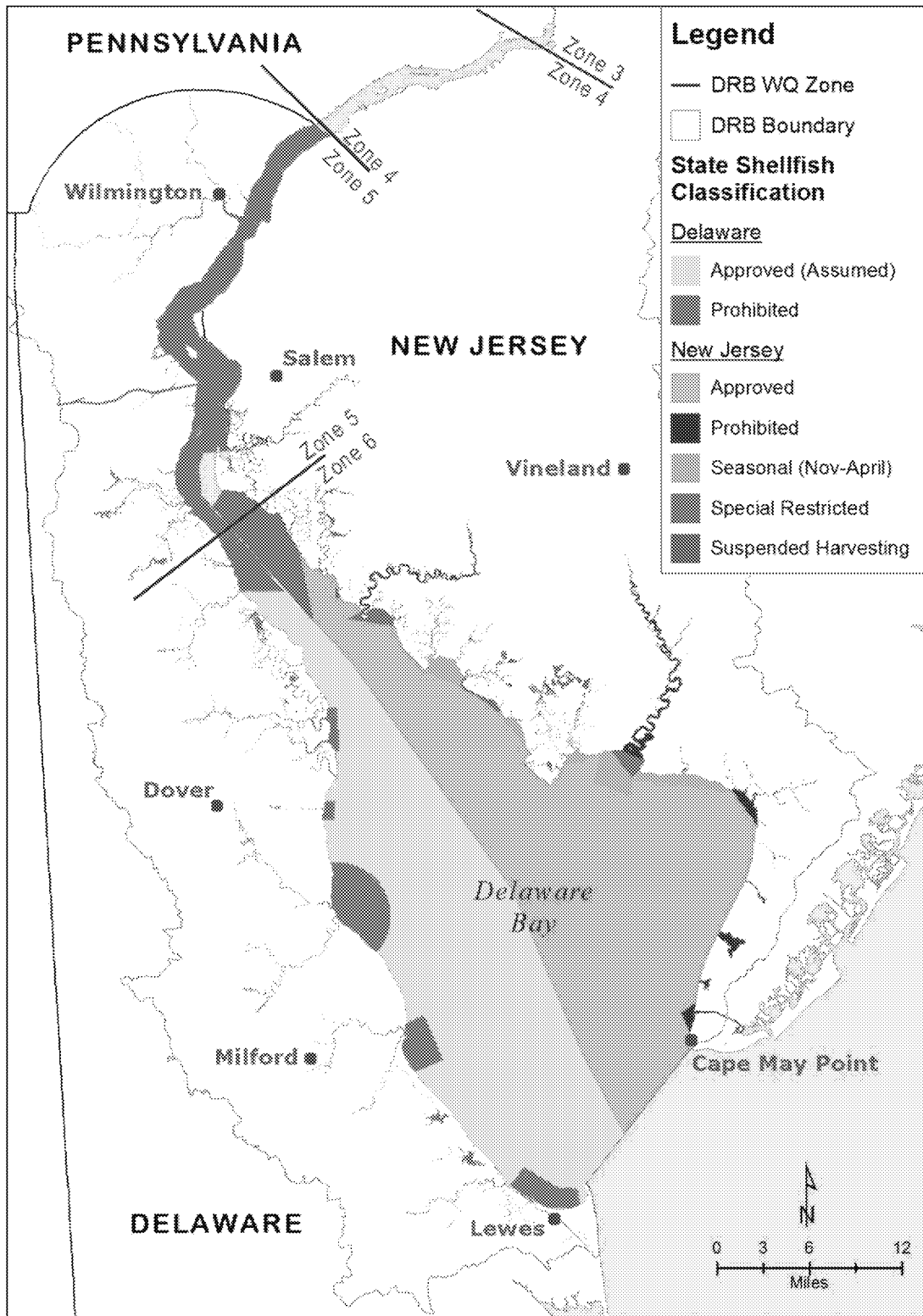


Table 23: Shellfish Consumption Designated Use Assessment Result

State	Approved (S)		Seasonal or Special Restricted (SS)		Prohibited (NS)	
	mi ²	%	mi ²	%	mi ²	%
Delaware	287.1	75.6	0	0	92.8	24.4
New Jersey	328.9	89.5	35.4	9.6	3.3	0.9

Assessment Summary

Table 24 below shows the summary of assessments for Aquatic Life, Public Water Supply, Recreation, and Fish Consumption. Meaningful assessment continues to be hampered by the requirement to indicate one exceedance plus one confirmatory exceedance as not meeting criteria and subsequently not supporting a designated use.

Assessment of Shellfish applies only to Zone 6 and utilizes shellfish-specific sub areas. The Shellfish assessment summary is provided in Table 23 in the previous section.

Table 24: Summary of the 2014 Assessment

Zone (AU)	Aquatic Life		Drinking Water		Recreation		Fish Consumption	
	2016	2014	2016	2014	2016	2014	2016	2014
1A	NS	NS ^A	NS ^A	NS ^A	ID	S	NS	NS
1B	NS	NS ^A	S	NS ^A	S	S	NS	NS
1C	NS ^A	NS ^A	S	S	S	S	NS	NS
1D	NS ^A	NS ^A	S	S	S	S	NS	NS
1E	NS	NS	NS ^A	NS ^A	S	S	NS	NS
2	NS ^A	NS ^A	NS ^A	NS ^A	S	NS	NS	NS
3	NS ^A	NS ^A	S	NS ^A	S	S	NS	NS
4	NS ^A	NS	N/A	N/A	S	S	NS	NS
5	NS	NS	N/A	N/A	S	S	NS	NS
6	NS	NS	N/A	N/A	S	S	NS	NS

Notes:

A – Based primarily on fewer than 10% exceedances of criteria

ID – Insufficient Data

N/A – Not applicable (no criteria in this assessment unit)

S – The use is supported in this Assessment Unit

NS – The use is not supported in this Assessment Unit

Recommendations for Future Action

Based on the results of this assessment cycle, we recommend additional effort prior to the next cycle to help address the following issues:

- Current guidance from EPA indicates that the proportion of allowable exceedances of conventional criteria must be adopted as part of criteria in order to be considered during assessment. Where the conventional criteria do not already include this information, EPA has indicated that assessors must indicate an assessment unit as having not met criteria when one exceedance plus one confirmatory exceedance are found. However, this approach is logically flawed and not supportable because it fails to recognize inherent measurement and analytical uncertainty, and imposes a wholly different standard than that which was in place at the time the criteria were developed. Prior to the next assessment cycle, DRBC should develop and adopt in Article 4, criteria implementation tables to assist in future assessment cycles.
- DRBC and its partner organizations must craft a specific plan to better define the linkage between atmospheric and meteorological drivers, in order to estimate the proportion of temperature exceedances attributable to potentially controllable anthropogenic activities.
- Good progress has been achieved on reducing the number of un-assessable parameters and zones with the establishment of permanent continuous water quality monitors in Zones 1A and 1B, through the National Park Service, and in Zone 2, through the USGS and Philadelphia Water Department. However, Zones 1C, 1D, and 6 remain without the benefit of continuous water quality monitors. DRBC and its partner organizations need to accelerate the pace of establishing continuous water quality monitoring programs where still needed.
- The DRBC recommends collection of high quality copper data utilizing clean sample collection, clean laboratory technique, and ICP/MS or equivalent low detection level analytical methods, as well as collection of site specific dissolved organic carbon (DOC). DRBC and its partner organizations must develop a consensus on appropriate management approaches toward achieving surface water quality standards for copper.
- Coordination among basin states and agencies should continue to ensure the use of the most appropriate analytical and assessment methodologies for polycyclic aromatic hydrocarbons (PAHs).
- Exceedances of aluminum criteria (acute and chronic freshwater objectives for the support of aquatic life) in Zone 4 warrant further attention.
- Additional monitoring and assessment of pesticides in Zones 2 through 5.
- Additional monitoring and assessment of toxics in Zone 1.
- Assessment priorities in the tidal River include further characterization of persistent and bioaccumulative perfluorinated compounds and a more comprehensive evaluation of potential ecological effects from pharmaceuticals in the estuary. Benchmark values for environmental safety are needed and in some cases water quality criteria may need to be derived for some emerging contaminants to facilitate future water quality assessment.

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DRAFT

Appendix A: Descriptions of DRBC Monitoring Programs

The surface water quality monitoring program utilized by the DRBC consists of the following programs:

- The upper, middle and lower non-tidal portions of the River (RM 330.7 to 133.4) are monitored through the *Scenic Rivers Monitoring Program*, a joint NPS and DRBC effort. Details about this monitoring program are available at:
<http://www.nj.gov/drbc/programs/quality/spw.html>
- The Estuary, or tidal portion of the Delaware River (RM 133.4 to the mouth of the Delaware Bay), is monitored through the *Delaware River Boat Run Monitoring Program*, a joint effort between the DNREC and DRBC. Details about the Boat Run monitoring program are available at:
<http://www.state.nj.us/drbc/quality/datum/ambient/>
- Periodic monitoring of Chronic Toxicity in the estuary is described at:
<http://www.state.nj.us/drbc/quality/toxics/wet/>
- The *Biological Monitoring Program* collects macroinvertebrate samples throughout the non-tidal River (RM 300.7 to 133.4) for assessment of Aquatic Life Use. More information about the Biological Monitoring Program is available at:
<http://www.state.nj.us/drbc/quality/reports/biological/index.html>

In addition, data obtained from other agencies' monitoring efforts are used to supplement data obtained through the DRBC sampling efforts. The other data sources include:

- DNREC Dioxins and Furans in Fish from the Delaware River Study,
- Pennsylvania Department of Environmental Protection (PADEP) Water Quality Network (WQN),
- New Jersey Department of Environmental Protection (NJDEP) Ambient Surface Water Monitoring Network (from STORET),
- New York State Department of Environmental Conservation (NYSDEC) Ambient Water Quality Monitoring Program (from STORET),
- United States Geological Survey (USGS) National Water Information System (NWIS),
- DRBC/USGS Cooperative Monitoring Program (continuous monitors),
- National Oceanic Atmospheric Administration (NOAA) Physical Oceanographic Real-Time System (PORTS) data, and
- EPA National Coastal Assessment Programs.

Appendix B: Links to DRBC Water Resources Management Programs

DRBC's water pollution control program is carried out through a series of interdependent steps and provides a rational approach to protecting and restoring water quality in the basin. The waters of the Basin are protected for designated uses with water quality criteria (WQC) that specify what levels of individual parameters are appropriate, based upon a review of the current scientific understanding about the needs of those uses. DRBC's monitoring programs provide a mechanism to evaluate how those WQC are being met, and assessment of those monitored data provide the link to how well the designated uses are being protected. The identified impairment of interstate waters in the Basin leads to the development of total maximum daily loads (TMDLs), issuing of permits and other mechanisms to reduce loading of pollutants in order to improve water quality to levels that meet the criteria. In addition, DRBC has other layers of protection (i.e., Special Protection Waters) that aim to maintain existing water quality where it is better than the water quality criteria. The links below provide access to much more detailed information on several of the key DRBC water resources management programs.

- Special Protection Waters
<http://www.state.nj.us/drbc/programs/quality/spw.html>
- Pollutant Minimization Plans
<http://www.nj.gov/drbc/programs/quality/pmp.html>
- Project Review / Docketing
<http://www.nj.gov/drbc/programs/project/>
- Southeastern Pennsylvania Ground Water Protected Area
<http://www.nj.gov/drbc/programs/project/pr/gwpa.html>
- Integrated Water Resource Management and Basin Planning
<http://www.nj.gov/drbc/programs/basinwide/>
- Estuary CBOD Allocations
The Commission determined that the 1964 carbonaceous biochemical oxygen demand (CBOD₂₀) of the effluent load to Zones 2, 3, 4, and 5 exceeded the waste assimilative capacity of those Zones to meet the stream quality objectives based upon numerical modeling study conducted in the late 1960s. In accordance with the regulations, the assimilative capacity of each Delaware Estuary Zone minus a reserve was originally allocated in 1968 among the individual dischargers based upon the concept of uniform reduction of raw waste in a Zone (Zones 2, 3, 4, and 5). Since 1968, the wasteload allocations for individual dischargers have been updated and documented by the Commission.

Appendix C: Toxic Pollutants Water Quality Assessment Details

Table C1: Human Health Objectives (Toxics MCLs) Assessment Results

Parameter	Maximum Contaminant Level (µg/l)	2016 Assessment/Zones monitored
Metals		
Arsenic	10	No exceedance (NE) Zones 1A, 1B or 6
Barium	2000	No exceedances Zones 1A and 1B
Beryllium	4	Not monitored (NM)
Chromium (trivalent)	100	NE Zones 2 and 3
Copper	1300	NE Zones 1, 2 and 3
Lead	15	NE Zones 1, 2 and 3
Selenium	50	NM
Pesticides/PCBs		
alpha-BHC	0.2	NM
beta-BHC	0.2	NM
gamma - BHC (Lindane)	2	One measurement and exceedance Zone 1D (no impairment) NE Zone 2,3 (2012 low DL study)
2,4-Dichloro-phenoxyacetic acid (2,4-D)	70	NM

Parameter	Maximum Contaminant Level (µg/l)	2016 Assessment/Zones monitored
Methoxychlor	40	NE single sample 10/11/2011 Zone 1D
Toxaphene	3	One measurement and exceedance Zone 3 (no impairment)
Dioxin (2,3,7,8-TCDD)	0.00003	NE Zones 2, 3 (2012 low DL study)
2,4,5 Trichloro-phenoxypropionic acid (2,4,5-TP-Silvex)	50	NM
Volatile Organic Compounds (VOCs)		
Benzene	5	NE Zones 1, 2 and 3
Carbon Tetrachloride	5	NE Zones 1, 2 and 3
1,2-Dichloroethane	5	Units reported as %
1,1-Dichloroethylene	7	NE Zones 1, 2 and 3
[1,2 - trans – Dichloroethene] 1,2 - trans - Dichloroethylene	100	NM
Dichloromethane (methylene chloride)	5	NE Zone 1B
Tetrachloroethylene (PCE)	5	NE Zone 1B
Toluene	1000	NE Zones 1, 2 and 3
Total Trihalomethanes	80	NM
1,1,1-Trichloroethane	200	NE Zones 1, 2 and 3
1,1,2-Trichloroethane	5	NE Zones 1, 2 and 3

Parameter	Maximum Contaminant Level (µg/l)	2016 Assessment/Zones monitored
Trichloroethylene	5	NE Zone 1B
Vinyl Chloride	2	NE Zone 1B
Polycyclic Aromatic Hydrocarbons (PAHs)		
Benzo(a)Pyrene	0.2	ND > 3 ug/L
Other Compounds		
Asbestos	7 million fibers/L	NM
Bis(2-Ethylhexyl) Phthalate	6	NM
Fluoride	4,000	NE Zones 1, 2 and 3
Nitrate	10,000	NE Zones 1, 2 and 3
Pentachlorophenol	1	NE Zones 1, 2 and 3

Table C2: Aquatic Life Objectives Assessment Results

Parameter	Freshwater Objectives (µg/l)		2016	Marine Objectives (µg/l)		2016
	Acute	Chronic		Acute	Chronic	
	Metals					
Aluminum ^{a,b}	750	87	Exceedances acute and chronic Zones 1B, 1E, 4 and chronic in Zone 1D	NA	NA	NM
Arsenic (trivalent) ^c	340	150	No exceedances 1A,1B	69	36	NE Zone 6
Cadmium ^c	0.651*EXP(1.0166*LN(hardness)-3.924)	0.651*EXP(0.7409*LN(hardness)-4.719)	Exceedances of acute and chronic in Zone1B with hardness <25 mg/L and J flagged data (no impairment with unflagged data)	40	8.8	NM
Chromium (trivalent) ^c	0.277*EXP(0.819*LN(hardness)+3.7256)	0.277*EXP(0.819*LN(hardness)+0.6848)	NM	NA	NA	
Chromium (hexavalent) ^c	16	11	Single chronic exceedance in Zones 5 & 6 (no impairment)	1,100	50	NE

Parameter	Freshwater Objectives (µg/l)		2016	Marine Objectives (µg/l)		2016
	Acute	Chronic		Acute	Chronic	
Copper ^{c,g}	$0.908 \cdot \text{EXP}(0.9422 \cdot \text{LN}(\text{hardness}) - 1.7)$	$0.908 \cdot \text{EXP}(0.8545 \cdot \text{LN}(\text{hardness}) - 1.702)$	Exceedances chronic using DRBC regulatory hardness but not site specific hardness Zone 5 Exceedances of acute and chronic in Zones 1A, 1B, and 1D; chronic in Zone 1E total copper	4.8	3.1	Exceedances Zones 5 and 6
Lead ^c	38	5.4	NE	210	8.1	NE
Mercury ^c	1.4	0.77	NE Zones 1 – 5	1.8	0.94	NE Zones 5 and 6
Nickel ^c	$0.846 \cdot \text{EXP}(0.846 \cdot \text{LN}(\text{hardness}) + 2.255)$	$0.846 \cdot \text{EXP}(0.846 \cdot \text{LN}(\text{hardness}) + 0.0584)$	NE Zones 1A, 1B, & Zones 2-5	64	22	NE Zones 5-6
Selenium ^a	20	5.0	NM	290	71	NM
Silver ^c	$0.85 \cdot \text{EXP}(1.72 \cdot \text{LN}(\text{hardness}) - 6.59)$	NA	NM	1.9	NA	NM
Zinc ^c	$0.95 \cdot \text{EXP}(0.8473 \cdot \text{LN}(\text{hardness}) + 0.884)$	$0.95 \cdot \text{EXP}(0.8473 \cdot \text{LN}(\text{hardness}) + 0.884)$	NE Zones 1A, 1B, & Zones 2-5	90	81	NE Zones 5-6

Parameter	Freshwater Objectives (µg/l)		2016	Marine Objectives (µg/l)		2016
	Acute	Chronic		Acute	Chronic	
			Pesticides/PCBs			
Aldrin	3	NA	NE Zones 2-5	1.3	NA	NE Zones 5 and 6
gamma - BHC (Lindane)	0.95	NA	One measurement and exceedance Zone 1D (no impairment) NE Zone 2,3 (2012 low DL study)	1.3	NA	NE Zones 5 and 6
Chlordane	2.4	0.0043	NE Zones 2-5	0.16	NA	NE Zone 5 and 6
Chlorpyrifos (Dursban)	0.083	0.041	NM	0.09	0.004	NM
DDT and metabolites (DDE & DDD) ^d	1.1	0.001	NE Zones 2-5	0.011	0.0056	NE Zones 5 and 6
Dieldrin	0.24	0.056	NE Zones 2-5	0.13	0.001	NE Zones 5 and 6
Endosulfan ^e	0.22	0.056	NE Zones 2-5	0.71	0.0019	NE Zones 5
Endrin	0.086	0.036	NE Zones 2-5	0.034	0.0087	NM
Heptachlor	0.52	0.0038	NE Zones 2-5	0.037	0.0023	NE

Parameter	Freshwater Objectives (µg/l)		2016	Marine Objectives (µg/l)		2016
	Acute	Chronic		Acute	Chronic	
Heptachlor Epoxide	0.52	0.0038	NE Zones 1D, 2, and 3 One measurement and exceedance Zone 4 (no impairment)	0.053	0.0036	One measurement and exceedance Zone 5 (no impairment)
Parathion	0.065	0.013	NM	0.053	0.0036	NM
PCBs (Total)	1.0	0.014	Not assessed ongoing TMDL	NA	NA	
Toxaphene	0.73	0.0002	One measurement and exceedance Zones 3 (no impairment)	5.0	0.03	One measurement and exceedance Zones 6 (no impairment)
Other Compounds						
Cyanide (free)	22	5.2		1	1	

Parameter	Freshwater Objectives (µg/l)		2016	Marine Objectives (µg/l)		2016
	Acute	Chronic		Acute	Chronic	
Pentachlorophenol	$e^{(1.005 \cdot \text{pH} - 4.83)}$	$e^{(1.005 \cdot \text{pH} - 5.29)}$	NE ≥ 4 µg/L DL Zones 2-5	13	7.9	NE ≥ 4 µg/L DL Zones 5-6
Indicator Parameters						
Whole Effluent Toxicity	0.3 Toxic Units _{acute}	1.0 Toxic Units _{chronic}	NE ^f	0.3 TU _a	1.0 TU _c	NE ^f

^a Total recoverable criterion

^b Aluminum criteria listed should be restricted to waters with pH between 6.5 and 9.0.

^c Dissolved Criterion

^d This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value.

^e This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

Criteria for cadmium, chromium(trivalent), copper, nickel, silver and zinc are hardness dependent and are expressed as the dissolved form (see Section 3.10.3.C.2. for form of metal).

^f Based on sampling in 2012, measured endpoints at eleven sites in the main stem of the Delaware River clearly did not indicate chronic toxicity to the tested species. However, three sites in main stem DRBC Water Quality Zone 5 warrant further assessment to confirm the existence and persistence of toxicity and to evaluate potential sources (chemical causes) of observed toxicity (<http://www.state.nj.us/drbc/quality/toxics/wet/>). As a follow-up to screening level toxicity tests

conducted in 2012, confirmatory samples were collected from DRBC Water Quality Zone 5 in the main stem Delaware River in 2013. Based on the test species tested and the measured endpoints, the water sampled did not confirm chronic toxicity to aquatic life at a biologically significant level.

⁶ Copper concentrations continue to be near water quality criteria in the Delaware Estuary with several apparent exceedances of the marine criteria in Zones 5 and 6. In the non-tidal river, exceedances of acute and chronic site specific criteria for copper were reported two times in Zone 1A and one time in Zone 1B, two times for acute criterion and six times for chronic criterion in Zone 1D. For total copper measurements compared to total copper criteria (using conversion factors) one exceedance in Zone 1D and one in Zone 1E are observed. The apparent exceedances are low in both frequency and magnitude. Assessment is complicated by factors such as field sampling and analytical issues with contamination, the applicability of DRBC's freshwater or marine criteria, a need to assess revisions to the current freshwater and marine criteria, and the influence of other water quality attributes that influence the partitioning and toxicity of copper. Therefore, copper levels in the Delaware River should be considered of concern warranting additional monitoring and assessment. Suggested studies include additional synoptic sampling surveys targeted to copper and other metals with finer spatial and temporal scales, as well as, further assessment including the evaluation of water quality models such as the Biotic Ligand Model to assess the frequency of criteria exceedances and the factors contributing to those exceedances. Coordination among basin states and agencies should continue to ensure the use of the most appropriate methods and procedures for the conduct of monitoring studies in the Basin, and the harmonization of water quality criteria and assessment methodologies.

NA = not available; NE = no exceedances; E = exceedances; NM = not monitored; DL detection limit

Table C3: Human Health Objectives (Carcinogens) Assessment Results

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016 assessment	MARINE OBJECTIVES (µg/l)	2016 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Metals					
Arsenic	*	NA		NA	
Pesticides/PCBs					
Aldrin	0.000049	0.000050	NE Zones 2-5	0.000050	NE Zones 5-6
alpha – BHC	0.0026	0.0049	NM	0.0049	NM
beta – BHC	0.0091	0.017	NM	0.017	NM
Chlordane	0.00080	0.00081	NE Zones 2-5	0.00081	NE
DDD	0.00031	0.00031	Exceedances Zone 2-5 (low DL study) single sample day	0.00031	NE Zone 6
DDE	0.00022	0.00022	Exceedances Zone 2 – 5 (low DL study) single sample day	0.00022	NE Zone 6
DDT	0.00022	0.00022	Exceedances Zone 2 - 5	0.00022	NE Zone 6

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016 assessment	MARINE OBJECTIVES (µg/l)	2016 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
			(low DL study) single sample day		
Dieldrin	0.000052	0.000054	Exceedances Zone 2 – 5 (low DL study) single sample day	0.000054	NE Zone 6
Heptachlor	0.000079	0.000079	NE Zones 2- 5	0.000079	NE Zone 6
Heptachlor Epoxide	0.000039	0.000039	Exceedances Zone 4 and 5 (low DL study) single sample day	0.000039	NE Zone 6
PCBs (Total)	0.0000444	0.0000448	Not assessed ongoing TMDL Exceedances in Zone 1	0.0000079	Not assessed ongoing TMDL
Toxaphene	0.00028	0.00028	NE Zones 2- 5	0.00028	NE

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016 assessment	MARINE OBJECTIVES (µg/l)	2016 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Volatile Organic Compounds (VOCs)					
Acrylonitrile	0.051	0.25	NM	0.25	NM
Benzene	0.61	14	NE Zones 2-5	14	NE
Benzidine	0.000086	0.00020	NM	0.00020	NM
Bromoform(tribromomethane)	4.3	140	ND > 0.5 ug/L Zones 2-5	140	ND > 0.5 ug/L Zones 5-6
Bromodichloromethane	0.55	17	NM	17	NM
Carbon Tetrachloride	0.23	1.6	NE Zones 2-5	1.6	NE Zone 6
Chlorodibromomethane	0.40	13	NE Zone 1B,	13	NE Zone 6

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016 assessment	MARINE OBJECTIVES (µg/l)	2016 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
			NE Zones 2-5		
Chloroform	5.7	470	NE 1B, 2,3 4, 5,6	470	NE 5-6
3,3 - Dichlorobenzidine	0.021	0.028	ND > 4 ug/L	0.028	ND > 4 ug/L
1,2 - Dichloroethane	0.38	37	Unit report %	37	
1,2 - Dichloropropane	0.50	15	ND > 0.1 ug/L Zones 2-5	15	ND > 0.1 ug/L Zones 5-6
1,3 - Dichloropropene	0.34	21	NM	21	NM
Dichloromethane (Methylene chloride)	*	590	NE	590	NE Zone 6
Tetrachloroethylene	0.69	3.3	NE Zone 1B	3.3	NE
1,1,2,2 - Tetrachloroethane	0.17	4.0	NE Zones 2-5	4.0	NE
1,1,2 - Trichloroethane	0.59	16	NE Zones 2-5	16	NE
Trichloroethylene	2.5	30	NE Zones 2-5	30	NE

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016 assessment	MARINE OBJECTIVES (µg/l)	2016 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Vinyl Chloride	0.025	2.4	NE Zone 1B	2.4	NM
Polycyclic Aromatic Hydrocarbons (PAHs)					
Benz[a]anthracene	0.0038	0.18	ND > 2 ug/L Zones 2 - 5	0.18	ND > 2 ug/L
Benzo[b]fluoranthene	0.038	0.18	ND > 2 ug/L Zones 2 - 5	0.18	ND > 2 ug/L
Benzo[k]fluoranthene	0.38	1.8	ND > 1 ug/L Zones 2-5	1.8	NE Zones 5 - 6
Benzo[a]pyrene	0.0038	0.018	ND > 3 ug/L Zones 2 - 5	0.018	ND > 3 ug/L
Chrysene	3.8	18	NE Zones 2 - 5	18	NE Zones 5 - 6
Dibenz[a,h]anthracene	0.0038	0.018	ND > 5 ug/L Zones 2-5	0.018	ND > 5 ug/L
Indeno[1,2,3-cd]pyrene	0.038	0.18	ND > 5 ug/L Zones 2-5	0.18	ND > 5 ug/L
Other Compounds					
Bis (2-chloroethyl) ether	0.03	0.53	ND > 2 ug/L Zones 2-5	0.53	ND > 2 ug/L Zones 5-6
Bis (2-ethylhexyl) phthalate	1.2	2.2	NM	2.2	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016 assessment	MARINE OBJECTIVES (µg/l)	2016 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
2,4 - Dinitrotoluene	0.11	3.4	ND > 1 ug/L Zones 2 – 3 NE Zones 4-5	3.4	NE Zones 5-6
1,2 - Diphenylhydrazine	0.036	0.2	NM	0.2	NM
Hexachlorobenzene	0.00028	0.00029	ND > 2 ug/L Zones 2-5	0.00029	ND > 2 ug/L Zones 5 -m6
Hexachlorobutadiene	0.44	18	ND > 2 ug/L Zones 2–3 NE Zones 4 -5	18	NE Zones 5-6
Hexachloroethane	1.4	3.3	ND > 3 ug/L Zones 2–3 NE Zones 4-5	3.3	NE Zones 5-6
Isophorone	35	960	NE Zones 2-5	960	NE Zones 5-6
N-Nitrosodi-N-butylamine	0.0063	14	NM	14	NM
N-Nitrosodi-N-methylamine	0.00069	3.0	NM	3.0	NM
N-Nitrosodiethylamine	0.0008	1.24	NM	1.24	NM
N-Nitrosodi-N-phenylamine	3.3	6	NE Zones 2-	6	NE Zones 5-6

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016 assessment	MARINE OBJECTIVES (µg/l)	2016 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
			5		
N-Nitrosodi-N-propylamine	0.0050	0.51	ND > 2 ug/L Zones 2-5	0.51	ND > 2 ug/L Zones 5-6
N-Nitrosopyrrolidine	0.016	34	NM	34	NM
Pentachlorophenol	0.27	3.0		3.0	
Dioxin (2,3,7,8 – TCDD)	0.000000005	0.0000000051	One Zone 5 exceedance in 2012 (low DL study) (no impairment)	0.0000000051	NE
2,4,6 - Trichlorophenol	1.4	2.4	NE Zones 2- 5	2.4	NE Zones 5-6

* The MCL for this compound applies in Zones 2 and 3 and is listed in Table 3.

NA = not available; NE = No Exceedance; NM = Not Monitored

Table C4: Human Health Objectives (Systemic Toxicants) Assessment Results

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016	MARINE OBJECTIVES (µg/l)	2016
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Metals					
Antimony	5.6	640	NE Zones 2-5	640	NE Zones 5-6
Arsenic	*	NA		NA	
Beryllium	*	420	NM	420	NM
Cadmium	3.4	16	NE Zones 1A, 1B NM Zones 2 - 5	16	NM Zones 5-6
Chromium (trivalent)	*	380,000	NM	380,000	NM
Chromium (hexavalent)	92	NA	NE Zones 2-5	NA	NE Zones 5
Chromium (total)	NA	750	NM	750	NM
Mercury	0.050	0.051	NE	0.051	NE
Methylmercury a	0.3 mg/kg fish tissue	0.3 mg/kg fish tissue	NE	0.3 mg/kg fish tissue	NE
Nickel	500	1,700	NE Zones 1A, 1B, 1D, 1E & Zones 2-5	1,700	NE Zones 5-6
Selenium	170	4,200	NE Zones 1A & 1B	4,200	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016	MARINE OBJECTIVES (µg/l)	2016
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Silver	170	40,000	NE Zones 1A & 1B	40,000	NM
Thallium	0.24	0.47	NM	0.47	NM
Zinc	7,400	26,000	NE Zones 1A,1B, 1D, 1E & Zones 2-5	26,000	NE Zones 5- 6
Pesticides/PCBs					
Aldrin	0.025	0.025	NE	0.025	NE
gamma - BHC (Lindane)	0.98	1.8	One measurement and exceedance Zone 1D (no impairment) NE Zone 2,3 (2012 low DL study)	1.8	NE
Chlordane	0.14	0.14	NE	0.14	NE
DDT and Metabolites (DDD and DDE)	0.037	0.037	NE	0.037	NE
Dieldrin	0.041	0.043	NE	0.043	NE
alpha -Endosulfan	62	89	NE	89	NE

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016	MARINE OBJECTIVES (µg/l)	2016
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
beta- Endosulfan	62	89	NE	89	NE
Endosulfan Sulfate	62	89	NE	89	NE
Endrin	0.059	0.060	NE	0.060	NE
Endrin Aldehyde	0.29	0.30	NE	0.30	NE
Heptachlor	0.18	0.18	NE	0.18	NE
Heptachlor Epoxide	0.0046	0.0046	NE	0.0046	NE
Total PCBs	0.00839	0.00849	Not assessed ongoing TMDL NE Zone 1	0.00149	Not assessed ongoing TMDL
Volatile Organic Compounds (VOCs)					
Acrolein	6.1	9.3	NM	9.3	NM
Benzene	*	3,100	NE Zones 2-5	3,100	NE Zones 5-6
Bromoform (tribromomethane)	650	9,600	NE Zones 2-5	9,600	NE Zones 5-6
Bromodichloromethane	680	NA	NM	NA	NM
Dibromochloromethane	680	21,000	NM	21,000	NM
Carbon Tetrachloride	*	150	NE Zones 2-5	150	NE Zones 5-6

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016	MARINE OBJECTIVES (µg/l)	2016
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Chloroform	68	2,100	NE Zones 1B, 2,3,4,5	2,100	NE Zones 5- 6
Chlorobenzene	130	1,600	NE Zones 2-5	1,600	NE Zones 5- 6
1,1 - Dichloroethylene	*	7,100	NE	7,100	NE
1,2 - trans - Dichloroethylene	140	10,000	NM	10,000	NM
1,3 - Dichloropropene	1,000	63,000	NM	63,000	NM
Ethylbenzene	530	2,100	NE Zones 2-5	2,100	NE Zones 5- 6
Methyl Bromide	47	1,500	NE Zones 2-5	1,500	NE Zones 5- 6
Methylene Chloride	*	260,000	NE	260,000	NE
1,1,2 – Trichloroethane	*	3,600	NE	3,600	NE
Tetrachloroethylene	*	1,300	NE	1,300	NE
Toluene	1,300	15,000	NE	15,000	NE
Polycyclic Aromatic Hydrocarbons (PAHs)					
Anthracene	8,300	40,000	NE Zones 2-5	40,000	NE Zones 5- 6
Fluoranthene	130	140	NE Zones 2-5	140	NE Zones 5- 6

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016	MARINE OBJECTIVES (µg/l)	2016
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Fluorene	1,100	5,300	NE Zones 2-5	5,300	NE Zones 5-6
Pyrene	830	4,000	NE Zones 2-5	4,000	NE Zones 5-6
Other Compounds					
Acenaphthene	670	990	NE Zones 2-5	990	NE Zones 5-6
Benzidine	59	140	NM	140	NM
Bis (2-chloroisopropyl) ether	1,400	65,000	NE Zones 2-5	65,000	NE Zones 5-6
Bis (2-ethylhexyl) phthalate	*	620	NM	620	NM
Butylbenzyl phthalate	1,500	1,900	NE Zones 2-5	1,900	NE Zones 5-6
2 - Chloronaphthalene	1,000	1,600	NM	1,600	NM
2 - Chlorophenol	81	150	NM	150	NM
Cyanide	140	140	NM	140	NM
Dibutyl Phthalate	2,000	4,500	NM	4,500	NM
1,2 - Dichlorobenzene	420	1,300	NM	1,300	NM
1,3 - Dichlorobenzene	420	1,300	NM	1,300	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016	MARINE OBJECTIVES (µg/l)	2016
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
1,4 - Dichlorobenzene	63	190	NM	190	NM
2,4 - Dichlorophenol	77	290	NM	290	NM
Diethyl Phthalate	17,000	44,000	NE Zones 2-5	44,000	NE Zones 5-6
Dimethyl Phthalate	270,000	1,100,000	NE Zones 2-5	1,100,000	NE Zones 5-6
2,4 - Dimethylphenol	380	850	NE Zones 2-5	850	NE Zones 5-6
2,4 - Dinitrophenol	69	5,300	NE Zones 2-5	5,300	NE Zones 5-6
2,4 - Dinitrotoluene	68	2,100	NE Zones 2-5	2,100	NE Zones 5-6
Hexachlorobenzene	0.35	0.36	NE Zones 2-5	0.36	NE Zones 5-6
Hexachlorocyclopentadiene	40	1,100	NE Zones 2-5	1,100	NE Zones 5-6
Hexachloroethane	20	46	NE Zones 2-5	46	NE Zones 5-6
Isophorone	6,700	180,000	NE Zones 2-5	180,000	NE Zones 5-6

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2016	MARINE OBJECTIVES (µg/l)	2016
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
2-Methyl-4,6-dinitrophenol	13	280	NM	280	NM
Nitrobenzene	17	690	NE Zones 2-5	690	NE Zones 5-6
Pentachlorobenzene	1.4	1.5	NM	1.5	NM
Pentachlorophenol	*	11,000	NE Zones 2-5	11,000	NE Zones 5-6
Phenol	10,000	860,000	NE Zones 2-5	860,000	NE Zones 5-6
1,2,4,5-Tetrachlorobenzene	0.97	1.1	NM	1.1	NM
1,2,4 - Trichlorobenzene	35	70	NE Zones 2-5	70	NE Zones 5-6
2,4,5-Trichlorophenol	1,800	3,600	NM	3,600	NM
Vinyl Chloride	*	10,000	NE Zone 1B	10,000	NM

* The MCL for this compound applies in Zones 2 and 3 and is listed in Table 3.

DL = Detection Limit; NA = not available; NE = No Exceedance; Nm = Not Monitored

For this assessment cycle, where DRBC has not adopted numeric toxics criteria (Zones 1A through 1E), to ensure attainment and maintenance of downstream water quality standards and to facilitate consistent and efficient implementation and coordination of water quality-related management actions in shared interstate waters, an assessment methodology based on the most stringent of basin state standards in Zones 1A through 1E is used in the assessment.

Some criteria require hardness values to compute the actual criteria numeric value. In these cases, toxics data from ambient water are compared to stream quality objectives using hardness values listed in DRBC Water Quality Regulations for Zones 2 through 5 (i.e., 74 mg/L as CaCO₂).

- An additional comparison is conducted as part of this assessment with site-specific paired hardness measured concurrently with toxic analytical parameters.
- For Zone 1 assessments, the actual criteria numeric value is computed with site-specific paired hardness measured concurrently with the toxic analytical parameter and the measured ambient water concentrations of copper were also compared to criteria numeric values calculated with median, minimum and maximum hardness values measured at the nearest interstate control point (ICP) or boundary control point (BCP).

For criteria expressed as the dissolved form of the metal, assessment of monitoring data is as follows:

- In assessment Zones with dissolved metals data collected, direct comparison to DRBC dissolved criteria;
- In assessment Zones with only total metals data collected (as noted in Table 5), comparison of total metals data to estimated total metals criteria using conversion factors listed in "Revised Procedure for Converting Total Recoverable Water Quality Criteria for Metals to Dissolved Criteria" <http://www.state.nj.us/drbc/regs/critmetals.pdf>.

The DRBC methylmercury criterion is fish tissue residue based as recommended by USEPA. No exceedances were observed in the fish species monitored by the DRBC in tidal and non-tidal waters (channel catfish, white perch, smallmouth bass and white sucker). Concentrations of mercury as wet weight in fish species sampled do not exceed a residue based water quality criteria of 300 ppb methylmercury in 2012 data or in 2011 data assuming methyl mercury is approximately 80% or less of total mercury measured in the fish tissue. In order to include available data for other aquatic biota in the water quality assessment, DRBC staff is soliciting data on methyl mercury in biota sampled from the Delaware River especially large fish that have a high potential for bioaccumulation of methyl mercury.

Appendix D: Taste and Odor Water Quality Assessment 2016

Table D1: Taste and Odor as Human Health Objectives Assessment Results

PARAMETER	STREAM QUALITY OBJECTIVE (µg/l)	2016 assessment
Phenol	300	NE
2 - Chlorophenol	0.1	NM
2,4 - Dichlorophenol	0.3	NE > 2 ug/L
2,4 - Dimethylphenol	400	NE
4 - Chloro - 3 - methylphenol	3.0 mg/l	NM
Pentachlorophenol	30	NE
Acenaphthene	20	NE
Chlorobenzene	20	NE
Hexachlorocyclopentadiene	1.0	NE
Nitrobenzene	30	NE

Appendix E: Public Participation and Coordination Process

<u>Action</u>	<u>Date</u>
Draft Assessment Methodology posted on the DRBC web site	September 9, 2015
Notice of Proposed Methodology for the 2016 Delaware River and Bay Water Quality Assessment Report and call for data published in the Federal Register	October 22, 2015

In addition to the above, the assessment schedule was discussed at DRBC advisory committee meetings during latter half of 2015. State cooperating agencies submitted minor comments on the methodology requesting clarification. Clarifications were included in the methodology description at the beginning of this report.

Initial assessment results were shared with State cooperating agencies as they became available during early 2016.